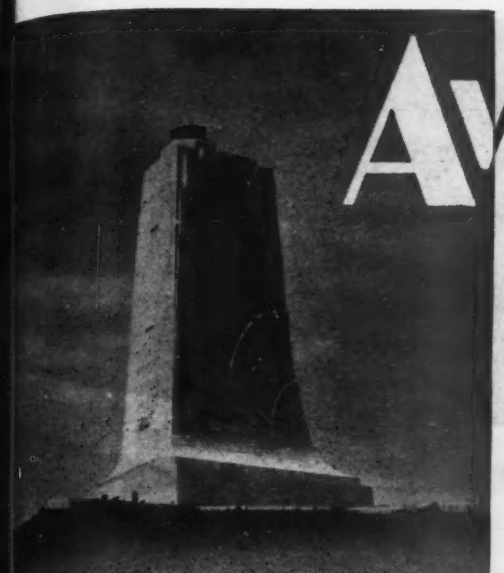

AVIATION

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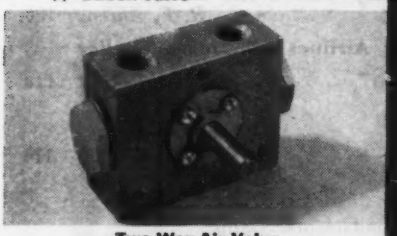
½" Check Valve

¼" Check Valve

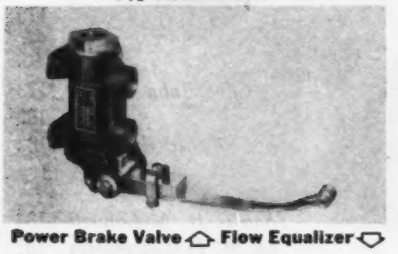


Two Way Air Valve

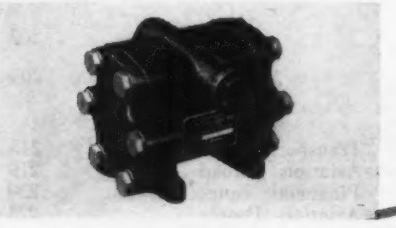
Four Way Landing Gear Selector Valve

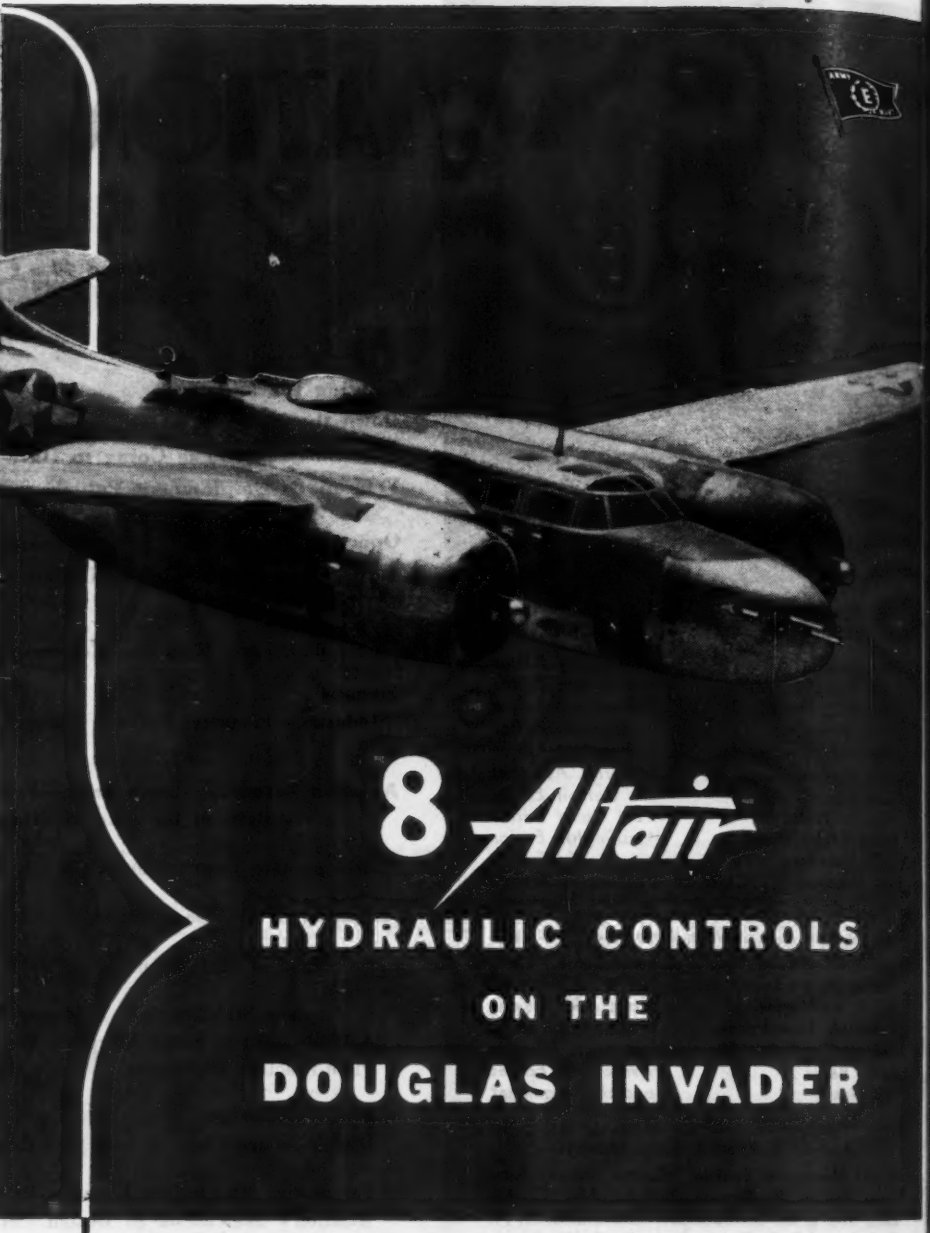
Pressure Regulator

7½" Accumulator



Power Brake Valve ◇ Flow Equalizer ◇





8 Altair HYDRAULIC CONTROLS ON THE DOUGLAS INVADER

Eight different components of the hydraulic system on the Douglas Invader are Altair products, designed and manufactured by Pacific Division, Bendix Aviation Corporation.

This is veteran equipment . . . . Douglas selected these hydraulic controls one year before Pearl Harbor and since then they have seen service on every A-26 airplane. The farsightedness of Douglas engineers in making these selections four years ago is evidenced by the fact that four of the original units which were designed to meet Douglas requirements are designated today as AN standards.

Pacific Division is proud, not only of the performance record of Altair hydraulic equipment on Douglas airplanes, but also of the fact that this equipment is being specified by every other major manufacturer of military airplanes in the United States today.

For data on any Altair product write Pacific Division, Bendix Aviation Corporation, North Hollywood, California. Sales Engineering offices in New York and St. Louis.

Pacific Division
BENDIX AVIATION CORPORATION
11630 SHERMAN WAY, NORTH HOLLYWOOD, CALIF.

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BRIEFING

It takes more than talk to realize the "full employment" everybody wants today and after the war, it takes real planning—now. United Air Lines has already put into action its own program for absorbing its returning war veterans, plus other fighting men who may join the company. UAL's Director of Personnel R. F. Ahrens tells on page 106 how the plan helps these men make the transition back into civilian life with greatest benefits both to themselves and the line.

Plenty of already-established fixed base operators, as well as men who want to go in the business, have asked just what they need in the way of tools and what the costs ranges would be. AVIATION not only got the answers by conducting a nation-wide survey but also determined the most efficient general layout for them. You'll find these answers on page 180 . . . And for those who are bothered by what to do about the showroom question, Capt. John Abiuso presents plans and specifications for two different-price-bracket display rooms. They're detailed on pages 178–9.

Beginning on page 182 is a guide for actual and potential airport operators, civic leaders, and all others interested in getting proper landing facilities for their communities. This plan, developed by the state of Louisiana, shows the step-by-step procedure for getting an adequate airport within a limited budget and still keeping the way open for almost unlimited expansion as conditions require.

There's no one so bitter as a customer who's been promised the world with a fence around it, but gets delivery on just a little chunk of the backyard. This industry of ours today faces a situation foreboding a lot of customers like that, even though most of the promising is being done by outsiders. The danger has become so tangible, in fact, that Aeronca's Vice-President Carl Friedlander has been moved to prepare a course of action by the industry which can avoid this deep pitfall. His program is outlined on page 114.

Personal flyers have been paying millions of dollars in gasoline taxes—and not getting a dime's worth of good from this money. It's one of those situations that can get even worse than it is, unless all who are interested in aviation progress rise up and do more than holler. John West, who uses his own planes for business and pleasure, has made a thorough study of state gasoline taxes, and it's quite an eye-opener. Some of his startling and discouraging facts, together with specific recommendations for remedies, are presented on page 112.

Prospectors for design details of the Jap's Zeke 32, a fighter on which the Nips really saved weight. AVIATION's Detroit Editor Chet Ricker (left, in "French Commando" hat) hangs by his toes while sketching aileron control bracket. You'll find this particular illustration on page 132, where it looks as though he'd done it standing to the camera man's right instead of from above and ahead—but don't ask us how he did it. Managing Editor Jack Foster (right, without shirt) digs into wing getting first-hand information for most complete report ever published on this Jap plane. Results of this joint prospecting expedition are a reader's bonanza, starting on page 119—the 12th in our unrivalled Design Analysis series.

Continuing his thorough-going analysis of feederline establishment and operation, James G. Ray this month sets up the operating considerations—delving into the balances necessary between speed and complete area coverage; the fundamentals of safety, comfort, convenience, and economy; the role of pickup operations; and types of aircraft required. This feature starts on page 108.

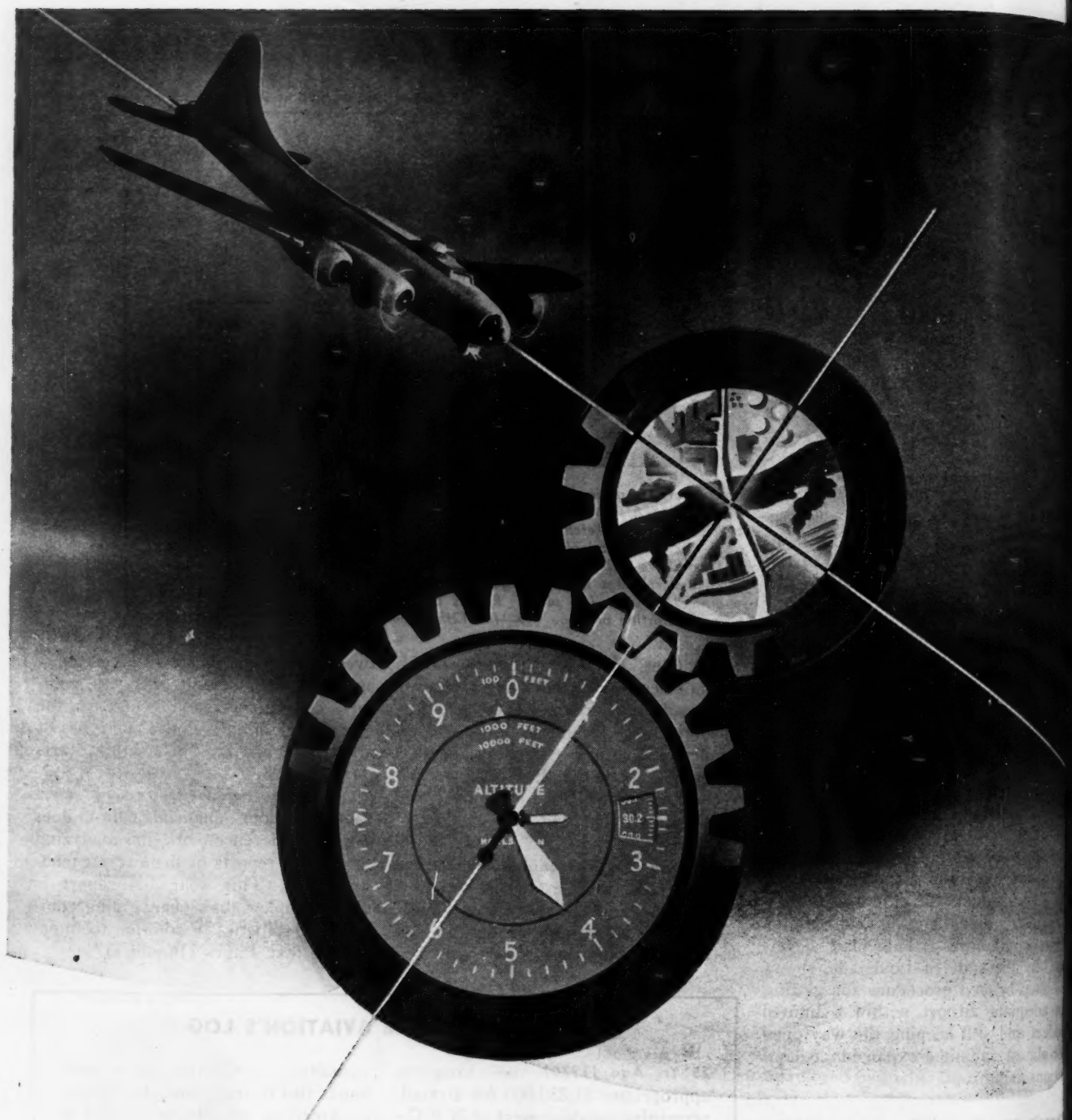
Each year our financial editor does a grand reference-work job analyzing the annual reports of the aircraft manufacturers. This year his report is more complete than ever, giving comparative statistics in addition to interpretive text. Pages 116 and 117.

Down the Years in AVIATION'S LOG

25 Yr. Ago (1920) — Congress appropriates $1,250,000 for airmail, permitting establishment of N.Y.C.-Chicago - Omaha - San Francisco route. . . Army constructs flying ambulance from DH-4. . . Bureau of Mines publishes standard test specifications for lubricants.

15 Yr. Ago (1930) — Madison Square Garden, N.Y.C., undergoes structural changes to accommodate huge Fokker F-32 plane at fourth air show. . . U. S. Geological Survey completes aerial mapping of Alaska. . . 20,576,468 gal. of gas and 1,028,823 gal. of oil were reported used last year (1929) by aircraft. . . Seventy Army and Navy planes stage sham battle over New York City. . . United secures control of NAT. . . Army completes 26-day air-battle maneuvers without casualty. . . 'Chutist jumps with hands tied to test automatic opener. . . American parachutes adopted as standard by Japanese Air Corps. . . MIT builds fog-study laboratory. . . British Columbia government will use seaplanes for fishery patrol.

10 Yr. Ago (1935) — Sixty percent of world air traffic is estimated to be under American flag. . . Ford seaplane shipped to Barranquilla Colombia, to open air service. . . PAA Clipper makes trial flight to Honolulu. . . Senate defeats $2,000,000 airmail appropriation proposal. . . Congress approves additional 500 air cadets for Army and Navy. . . Airline time for New York City-Chicago run cut to 4 hr. 20 min. . . Sikorsky S-39 sets amphibian altitude record of 18,642 ft. and speed record of 99.95 mph. for 621 mi.



UNKNOWN TO MANY in the aircraft field, the versatile Kollsman Sensitive Altimeter has been playing an important part in precision bombing by our air forces, providing the vital altitude information for the correct setting of the bombsight. Accuracy in indicating pressure differences at high altitudes is one of the things that has made the Kollsman Sensitive Altimeter suitable for this job. With standard models already accurately indicating to 50,000 feet, and others under development with ranges up to 80,000 feet, the way is already well paved to accurate indication of altitude for whatever the future brings — to transport or military aviation — in the way of flight in the stratosphere.

KOLLSMAN AIRCRAFT INSTRUMENTS

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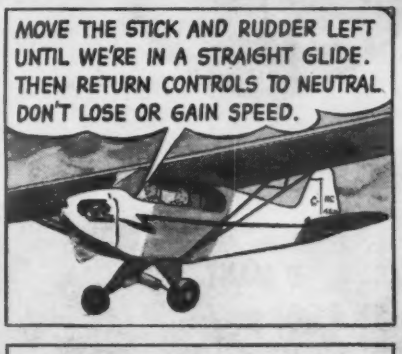


NOTE: This lesson and others that will follow explain only the fundamentals. See your Piper Cub dealer for actual flying instruction.

MOVIE FILMS AVAILABLE

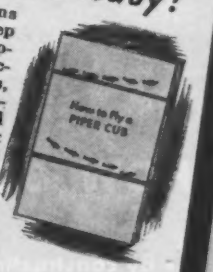
Movie films that will be a great help in teaching the fundamentals of flying and plane construction are available to you. Write Piper Aircraft Corporation, Lock Haven, Penna. for information on films showing "How to Fly" and "The Construction of a Light Airplane."

IS YOUR TOWN READY TO FLY?

It should plan landing facilities now—for its citizens and its future. The booklet, "What Your Town Needs for the Coming Air Age," illustrates various types. It covers benefits, where to build and how to start. For your free copy, write Piper Aircraft Corporation, Dept. A55W, Lock Haven, Pennsylvania.

Send for Your "How to Fly" Booklet Today!

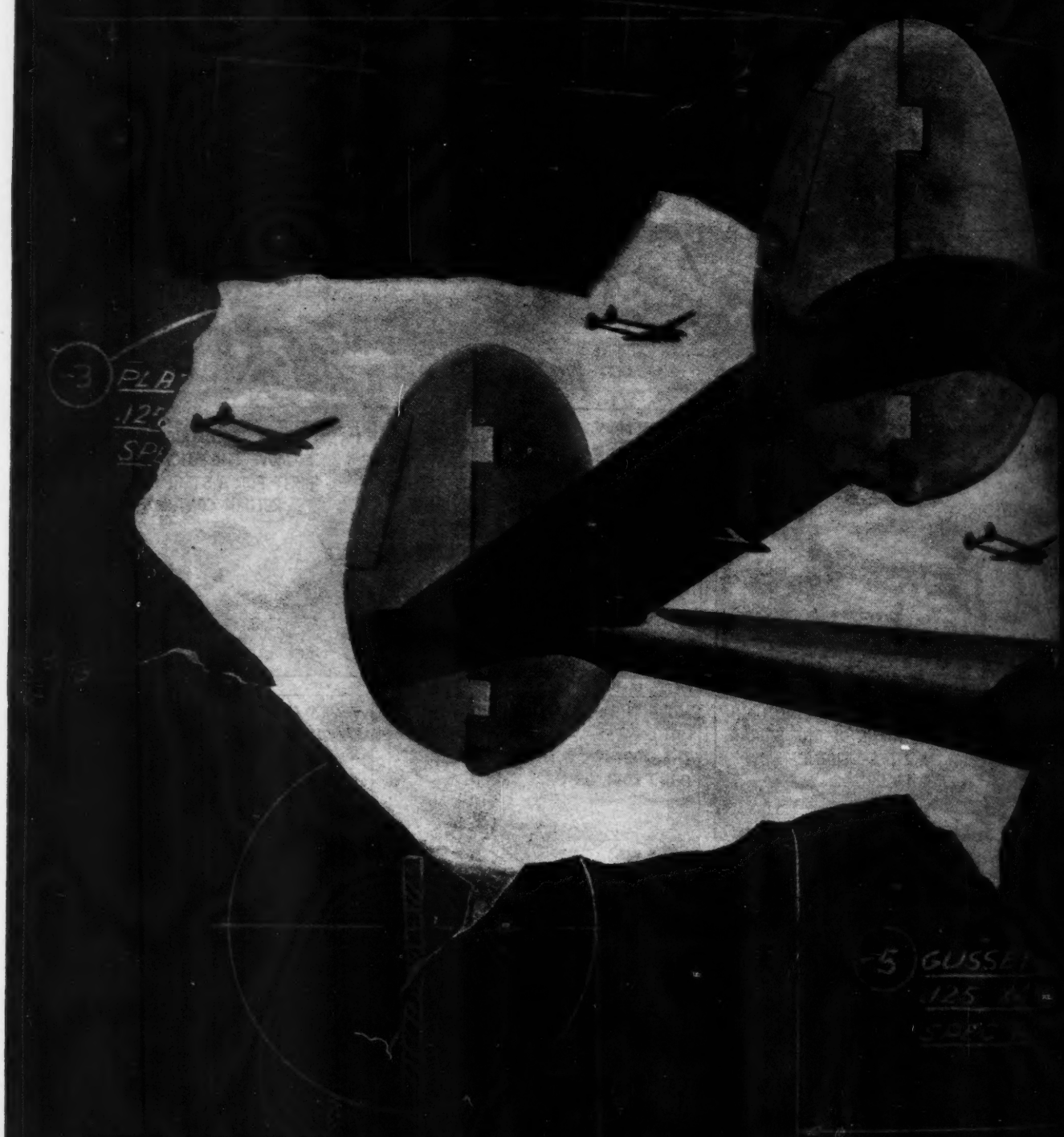
Booklet contains over 50 step-by-step photos and descriptions, full-color pictures of Piper Cubs, color drawings of instrument panel and controls. For your copy, write Piper Aircraft Corporation, Dept. A55, Lock Haven, Penna. Enclose 10c in stamps or coin for postage-handling.



PIPER CUB

Points the Way to Wings for ALL Americans

GOODYEAR AIRCRAFT



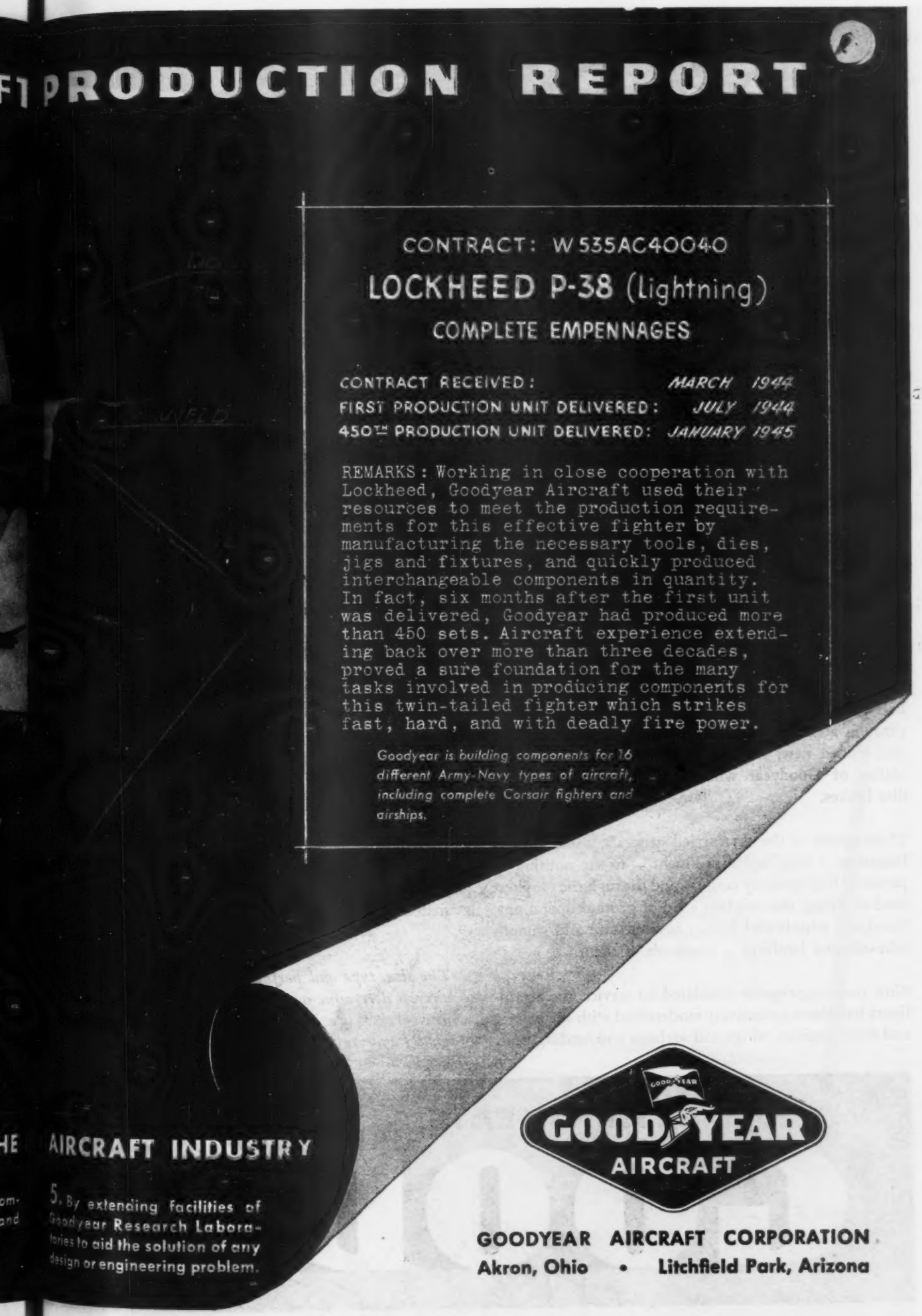
HOW GOODYEAR AIRCRAFT CORPORATION SERVES THE

1. By constructing major components to manufacturers' specifications.

2. By designing parts for all types of airplanes.

3. By re-engineering parts for quantity production.

4. By building complete airplanes and airships.


PRODUCTION REPORT
CONTRACT: W 535AC40040
LOCKHEED P-38 (Lightning)
COMPLETE EMPENNAGES
CONTRACT RECEIVED: MARCH 1944
FIRST PRODUCTION UNIT DELIVERED: JULY 1944
450TH PRODUCTION UNIT DELIVERED: JANUARY 1945
REMARKS: Working in close cooperation with Lockheed, Goodyear Aircraft used their resources to meet the production requirements for this effective fighter by manufacturing the necessary tools, dies, jigs and fixtures, and quickly produced interchangeable components in quantity. In fact, six months after the first unit was delivered, Goodyear had produced more than 450 sets. Aircraft experience extending back over more than three decades, proved a sure foundation for the many tasks involved in producing components for this twin-tailed fighter which strikes fast, hard, and with deadly fire power.
Goodyear is building components for 16 different Army-Navy types of aircraft, including complete Corsair fighters and airships.
AIRCRAFT INDUSTRY
5. By extending facilities of Goodyear Research Laboratories to aid the solution of any design or engineering problem.
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PROOF—
AND PLENTY!
In Far-Ranging Flight Service For The Air Transport Command, TWA Stratoliners Made Hundreds of Happy Landings on Goodyear Wheels and Multiple Disc Brakes

THE only four-engined transport planes in domestic air service in America at the time of Pearl Harbor, the Stratoliners of TWA have completed two and a half years of Air Transport Command operation. And, through all kinds of landings on all kinds of terrain, they added new, impressive evidence of the dependability of Goodyear wheels and Goodyear multiple disc brakes.

These giants of the sky carried generals, admirals, ambassadors, a king and a president — to say nothing of precious, high-priority cargo — and through the toughest kind of flying, the toughest kind of ground operations, Goodyear wheels and brakes insured safe and smooth take-offs and landings — hundreds of them.

Now resuming regular scheduled air service, the Stratoliners have been extensively modernized with the newest and finest engines, wings, tail surfaces and landing gear. Naturally, Goodyear wheels, brakes, tires and tubes — the kind that served so well in two and a half years of over-ocean flying — were specified.

Other airlines, in both their domestic and overseas flying, have found Goodyear tires and brakes the preferred equipment by proved experience.

For best take-off and landing performance, airlines, manufacturers and private flyers are finding it's wise to specify Goodyear tires, tubes, wheels and brakes. This is the best way to get the balanced combination, the matched unit that gives unexcelled service.

• • •

The size, type and performance characteristics of your aircraft determine whether Goodyear multiple or single disc brakes are most desirable. Our engineers will gladly analyze your particular requirements.

THE TIRE IS THE GOODYEAR ALL-WEATHER

The tire that helped set this wartime service record is the Goodyear All-Weather—one of the many types and sizes in the Goodyear line, the most complete line of airplane tires.

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YOU GET CORROSION RESISTANCE

Plus... Easy, Low Cost STAMPING FORMING DRAWING

Have you considered the greater utility advantages you can get by using Stainless Steel in your products?

For instance, you can give your products positive protection against heat and corrosion; you can provide them with 50% greater strength than ordinary cold-rolled steel; you can choose from a wide range of physical properties to meet specific requirements.

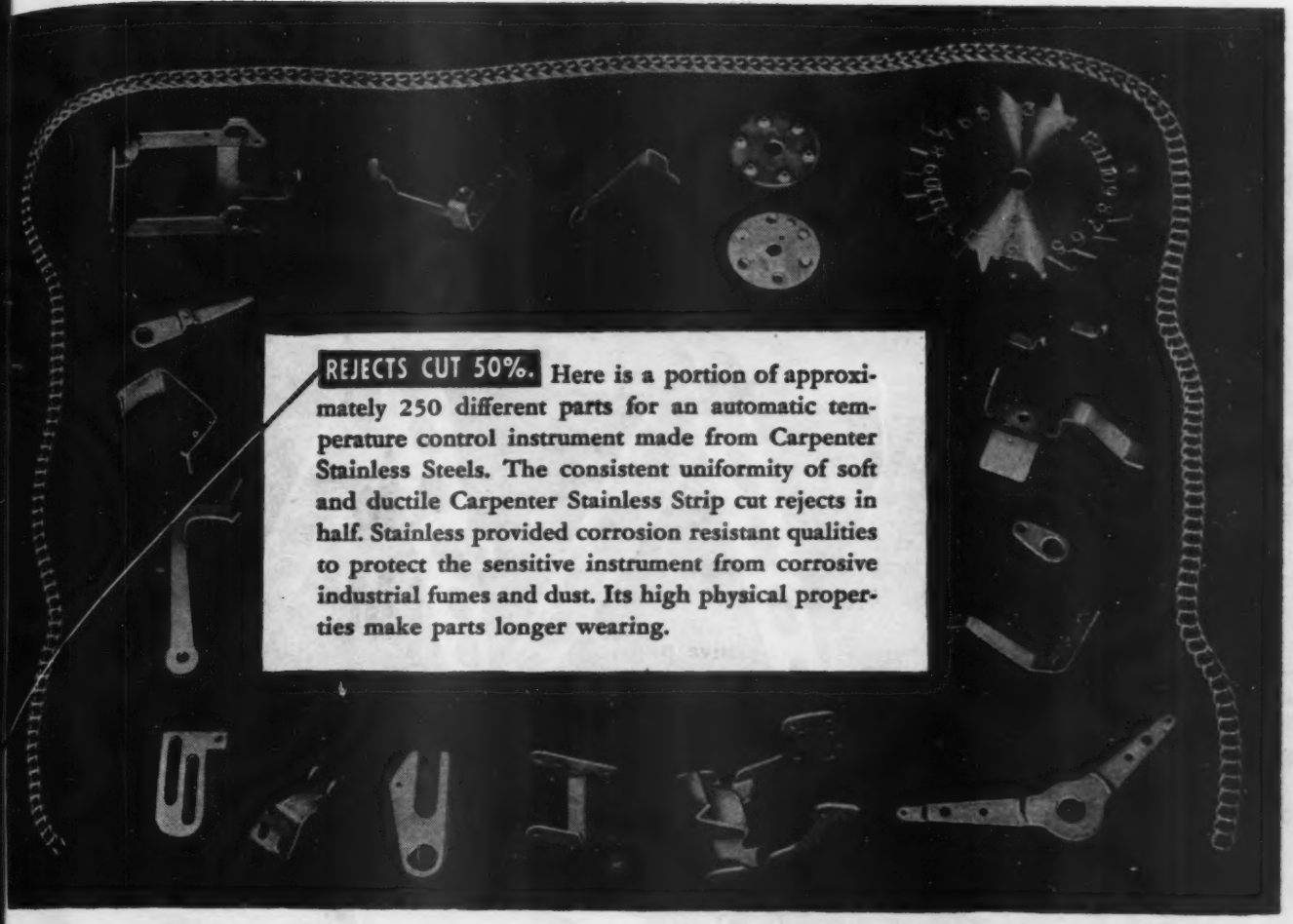
Just be sure when you select a Stainless Steel that you get one that works easily and economically in your fabricating shop. Carpenter, for instance, has spent years of intensive research developing soft and ductile Stainless Strip that blanks cleanly, forms readily, deep-draws easily. Exacting control through every step in manufacture, gives this Stainless Strip the consistent uniformity, lot after lot, that pays off in faster production runs with fewer rejects and less die wear.

Let our diversified Stainless experience help you to solve your specific problems. Call in your nearby Carpenter representative and let him help select the Stainless Strip that will make your production job easier and build extra service life into your products. See him today or write us at the mill.

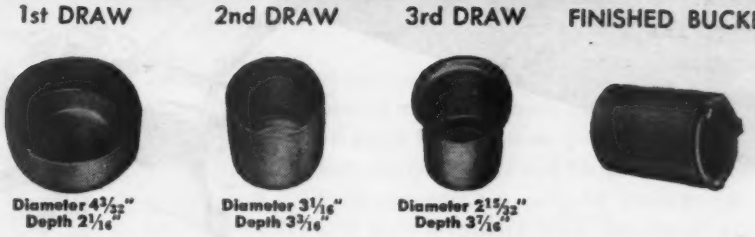
And if you do not already have a copy of "Working Data for Carpenter Stainless Steels," drop us a line on your company letterhead, indicating your title.

Give Your Products These Advantages . . . With CARPENTER Stainless

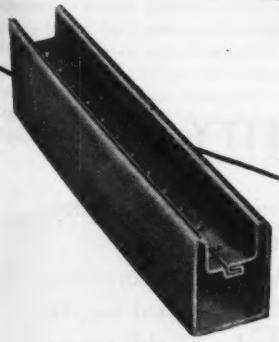
- Strength and Rigidity
- Heat Resistance
- Weight Saving
- Freedom from Rust
- No Plating to Peel
- Ease of Assembly
- Longer Product Life
- Sales Appeal



REJECTS CUT 50%. Here is a portion of approximately 250 different parts for an automatic temperature control instrument made from Carpenter Stainless Steels. The consistent uniformity of soft and ductile Carpenter Stainless Strip cut rejects in half. Stainless provided corrosion resistant qualities to protect the sensitive instrument from corrosive industrial fumes and dust. Its high physical properties make parts longer wearing.



NO PROCESS ANNEALING was needed to deep draw this steam trap bucket. Have you considered the economies you can gain and the trouble you can avoid by making your deep drawn parts from easy-working Carpenter Stainless Strip?



TOUGH PROBLEM SOLVED. This lock seam presented a difficult fabricating problem until Carpenter Stainless Strip went on the job. For planning your new or redesigned products, be sure to specify Carpenter uniform, soft and ductile Stainless Strip.

The Carpenter Steel Company • 128 W. Bern Street • Reading, Pa.

Carpenter STAINLESS STEELS

BRANCHES AT
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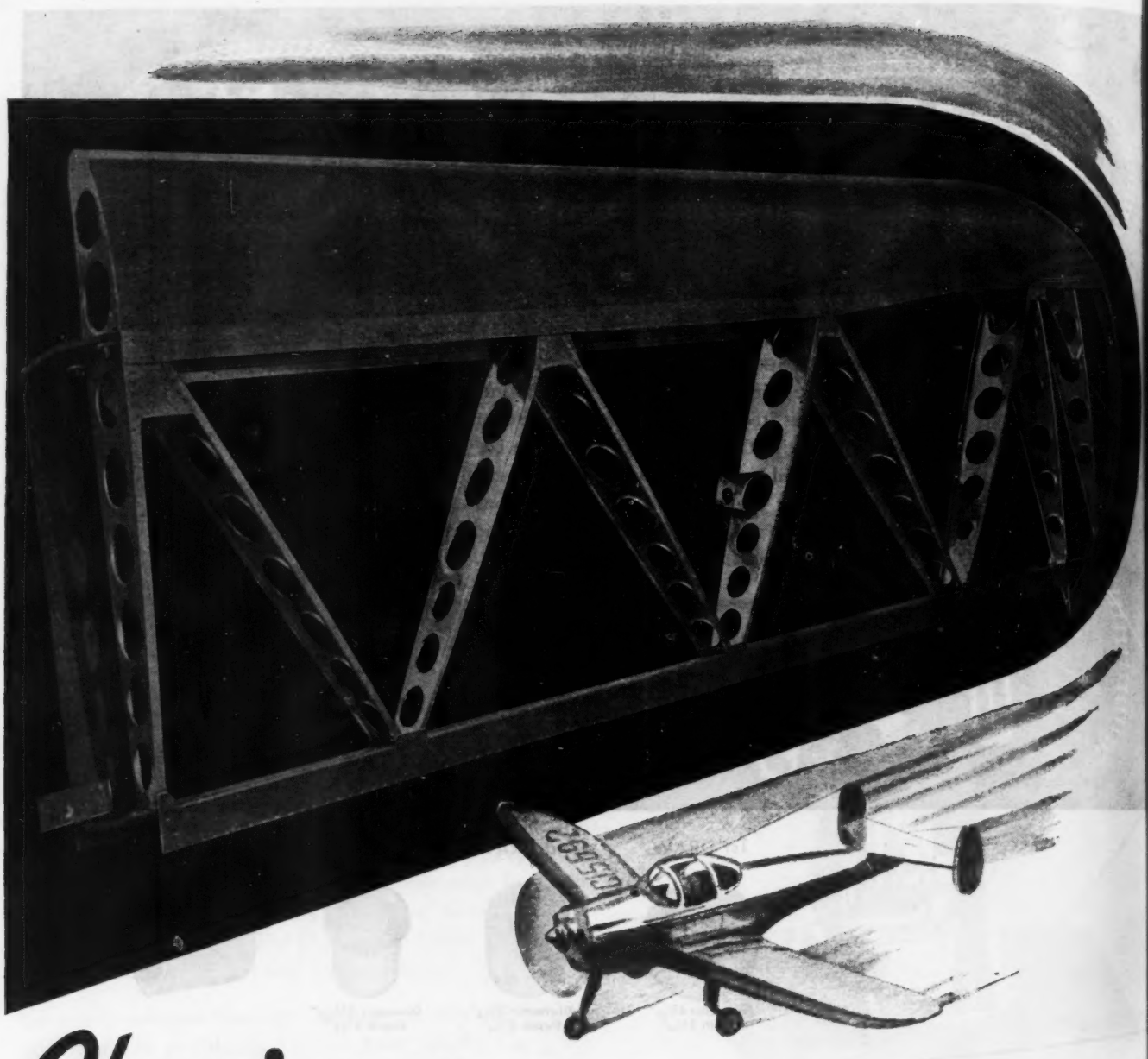

Aluminum

FOR TRANSPORT—PLANE DEPENDABILITY

The trend in postwar personal planes is to metal construction. This Ercoupe aluminum wing structure is indicative of that trend. It permits higher factors of safety without adding weight, greater simplification, fewer parts, lower assembly costs.

It is logical that the warplane builders of today, having learned the inherent aerodynamic advantages of aluminum, will employ it generously in their postwar planes.

Alcoa's lightweight, high strength, corrosion resistant aluminum alloys are destined to give the flying public, personal planes with transport-plane dependability. ALUMINUM COMPANY OF AMERICA, 2182 Gulf Building, Pittsburgh 19, Pennsylvania.

ALCOA FIRST IN ALUMINUM

ALCOA ALUMINUM

XLO

EX-CELL-O *for* PRECISION

. . . to Produce Parts FASTER, MORE ECONOMICALLY *and with* GREATER ACCURACY *See* EX-CELL-O *First*

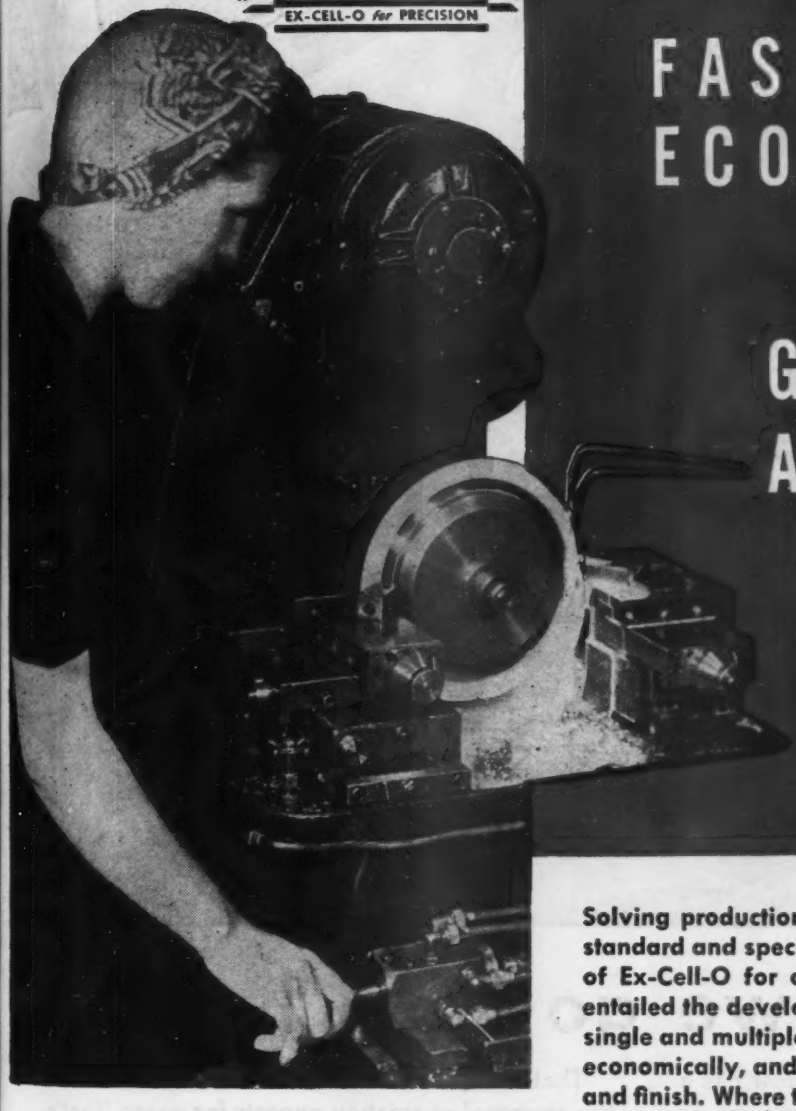

Illustration above shows fixture developed by Ex-Cell-O for use in facing both sides of aircraft flange and in turning hub diameter on each side, the fixture being operated by a hydraulic cylinder connected to the machine circuit. It carries four tungsten carbide tools that are synchronized mechanically and have individual micro-adjustment in two directions. All four tools reach the end of their cut simultaneously. *Machine used:* Ex-Cell-O 112-C Precision Boring.

Solving production problems for American industry with standard and special machine tools has been the business of Ex-Cell-O for over twenty-five years. Often this has entailed the development of special purpose machines for single and multiple operations . . . to do work faster, more economically, and with a much higher degree of accuracy and finish. Where the quantities have justified it, Ex-Cell-O has not only designed and built special machines to produce parts of improved quality but has undertaken actual production and assembly of these parts in its own plant, using to practical advantage Ex-Cell-O's complete heat treat equipment and widely-experienced production and inspection staffs. The days immediately ahead will offer many opportunities for the kind of engineering and production assistance that Ex-Cell-O can give so well. Ex-Cell-O's extensive facilities are well worth your consideration. Write to Ex-Cell-O Corporation in Detroit today.

If you're interested in planning production with precision, send for this new catalog on Ex-Cell-O Way Machines. Ask for Bulletin No. 31631.

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EX-CELL-O *makes* Special Multiple Way-Type Precision Boring Machines • Special Multiple Precision Drilling Machines • Precision Thread Grinding, Boring and Lapping Machines Broaches and Broach Sharpening Machines • Hydraulic Power Units • Grinding Spindles • Drill Jig Bushings • Continental Cutting Tools • Tool Grinders • Fuel Injection Equipment • R. R. Pins and Bushings • Pure-Pak Paper Milk Bottle Machines • Aircraft and Miscellaneous Production Parts.

"Where do we go from here?"

That natural question of the bomber crew has a parallel in the problem of the oil refiner. As planes grow more powerful, and engines improve, aviation oil must keep in step. What will be tomorrow's demands? How can oil be bettered to meet them?

Wolf's Head engineers have been answering that question since the earliest days of flying. They have kept constant contact with airplane designers, improving Wolf's Head Oil as aviation advanced. They themselves have contributed to the progress of flying by anticipating the needs of the industry.

That's why Wolf's Head Oil has won and held the approval of aviation experts for years. That's why leading engine makers today use it for critical tests and break-in runs. That's why it is the choice of allied aviators on fighting fronts all over the world.

Tomorrow may bring revolutionary developments, but Wolf's Head will keep pace with aviation needs. You can mark it down as certain that this 100% Pennsylvania Oil will continue to be "the finest of the fine." Wolf's Head Oil Refining Company, Oil City, Pa.—New York 10, New York.

★ ★ ★ ★ ★ **WOLF'S HEAD**

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100% PENNSYLVANIA

AVIATION OIL

"For Over Half a Century Wolf's Head Has Been Recognized as an Outstanding Leader in the Production of Extra Fine Automobile Oils and Lubes"

● **Accuracy and dependability in aircraft instruments are the two most important things today. These instruments must also be built to withstand the punishing heat of the tropics as well as the cracking cold of the arctic circle.**

The acceptance of HICKOK by the armed forces and the common request "Hickok or equivalent" is a fine tribute to a high standard of excellence.

For more than a third of a century HICKOK instruments have been noted for high precision, fine accuracy and long life. That is why they have long been held in highest esteem by the men who know meters and instruments. Write for catalogue.

THE HICKOK ELECTRICAL INSTRUMENT COMPANY

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to 5/8" MAXIMUM O.D.

IN THESE METALS:

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Temper #2 . . . Half-hard
Temper #3 . . . Full-hard
Special tempers to your specifications

OR ANODE AND CATHODE SLEEVES:

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THE BIG NAME IN SMALL TUBING

SUPERIOR TUBE COMPANY, NORRISTOWN, PENNSYLVANIA

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FOR EVERY SMALL TUBING APPLICATION FROM 5/8" OD DOWN

SUPERIOR Seamless in various analyses. **WELDRAWN** Welded and drawn Stainless, "Monel" and "Inconel"

SEAMLESS and Patented LOCKSEAM Cathode Sleeves

RELIABLE POWER FOR AIRCRAFT RADIO OPERATION

• A more dependable method of powering the two-way radios for light planes—to give an extra margin of safety—is Vibrator Power Supplies as developed by Electronic Laboratories. One exclusive E·L feature which will be available after the war involves vibrators operating in parallel to assure a reserve power source for added protection.

Vibrator Power Supplies are enjoying increased acceptance in the aviation field. Their complete reliability, efficiency and assured high altitude operation are the added safety factors that are vital to the aircraft industry.

The life of Vibrator Power Supplies is far beyond the C.A.A. overhaul requirement. Maintenance time and expense is cut to a minimum because it is not necessary to disassemble and rebuild an E·L Vibrator Power Supply.

The development of this method of power adaptation has led to many exclusive E·L advantages such as constant output voltage despite wide fluctuations of input voltages, and power outputs up to 1000 watts. These features, combined with the proved reliability, efficiency and minimum maintenance, make E·L Vibrator Power Supplies ideal for aircraft use.

Standard Power Supply Model 601

A variety of E·L converters will be available for powering light plane radio—from the multiple vibrator type mentioned above to the Model 601 illustrated below.

Model 601 provides high voltage DC from a 6 volt storage battery. Light weight and efficient, it gives long reliable service. Input: 6 volts DC; Output: 225 volts DC at 50 ma, 250 volts DC at 65 ma, 275 volts DC at 80 ma and 300 volts at 100 ma; Output Power: 30 watts maximum. Size: 4¾x4x6 in. Weight: 6 lbs.

Electronic LABORATORIES INC.

VIBRATOR POWER SUPPLIES FOR LIGHTING COMMUNICATIONS ELECTRIC MOTOR OPERATION • ELECTRIC ELECTRONIC AND OTHER EQUIPMENT

Plug this
into

New, Portable Janitrol Aircraft Heater

The photograph above shows one of the models of the new line of Janitrol Portable Aircraft Heaters. This model has an output capacity of 40,000 Btu's per hour. The overall size is approximately 3 feet long and 1 foot square, weighs under 40 pounds. The fuel tank has a capacity for 8 hours of continuous heater operation. Fuel supply will last longer when heater is cycling.

The unit assembly consists of a tamper-proof stainless steel housing.

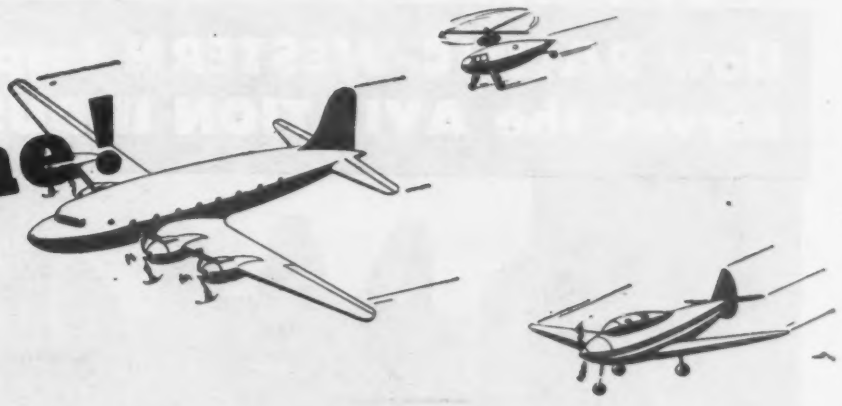
Unit is equipped with Fuel Pump and Relief Valve, Fuel Pressure Regulator, Fuel Filter, Magnetic Fuel Valve, Ignition Coil Box with high tension cable to spark plug, 210°-180° Adjustable Temperature Control (cycling switch), High Limit Switch, Delay Action Fan Switch, Signal Lamp with switch, Relay, Electrical Overload Circuit Breaker. Axial Flow Fan with ½ h. p. motor for 24 volts operation.

Data on other models with larger and smaller capacities is available.

Janitrol

SURFACE COMBUSTION · TOLEDO 1, OH

heater your plane!



SECURE heater in position, plug it into an electrical outlet, run the exhaust out through the side of the plane. That's all there is to it. Now your plane has *heat . . . even if it wasn't originally designed to make provision for a heating system!*

These new Janitrol Portable Aircraft Heaters are completely self-contained units, designed for use up to 15,000 feet altitude. Each model is equipped with its own fuel tank, fuel pump, air fan and motor, and automatic controls. You don't have to build scoops for ram air on your plane, because both circulating and combustion air is taken from the interior of the plane. With a 40,000 Btu output capacity heater, you have at —65° F. outside temperature, heat equivalent to a ram-operated heater of 125,000 Btu's, because you don't have to heat up great volumes of incoming cold air. This means savings in heater size, weight, and fuel consumption. And you can have heat *on the ground* as well as in the air because Janitrol Portable Aircraft Heaters operate independently of plane engines.

Think of the Possibilities!

When you carry passengers you have comfortable heat. When you carry cargo you can *remove the heater* and use it for other purposes.

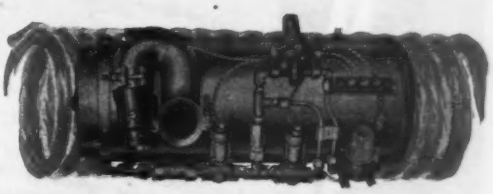
Your engine refuses to start in cold weather. You lift out your heater and direct a stream of warmed air around the engine.

You may operate a helicopter. Six-directional motion makes ram equipment unfeasible. With the right type and size of Janitrol Portable Aircraft Heater no plane motion nor ram air is needed.

Above all, your assurance of complete satisfaction is the fact that these Janitrol Heaters operate on the same exclusive *whirling flame* principle which has made Janitrol Aircraft Heating Equipment so outstandingly successful.

The development of new methods of heating and their application to many uses is one of the reasons why industry looks to Surface Combustion for progress in heating.

Our Engineering Staff is ready to discuss the application of Janitrol Aircraft Heaters for your requirements. For more information on the latest Janitrol developments, write Surface Combustion, Toledo 1, Ohio.



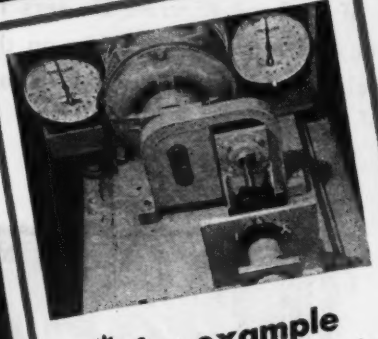
The famous Janitrol Aircraft Heater with the whirling flame, famous in Allied planes all over the world.

MAKERS OF:

JANITROL Aircraft and Portable Heaters • JANITROL Gas-Fired Forced Air and Gravity Furnaces, Unit Heaters and Conversion Burners for commercial, industrial and residential heating • S. C. Industrial Heat-Treating Furnaces, Special Atmosphere Generators and Industrial Gas Burners • KATHABAR Humidity Control Systems

America's oldest and largest manufacturer of gas-fired industrial and domestic heating equipment, with more than 30 years' experience in combustion research, and in the application, control and handling of heat.

How PACIFIC-WESTERN Inspection Department serves the AVIATION INDUSTRY



*** for example**

Bombdoor actuator unit undergoing inspection department efficiency test. Each P-W actuator is thoroughly checked for efficiency, vibration, heating, grease-leakage, and must pass exacting performance standards. Besides the above production tests each prototype undergoes rigorous life, winterization and performance tests.

The final O.K.—the decision that a gear or a machine will serve you well and continuously is the responsibility of Pacific-Western Inspectors. They regularly test rough castings, forgings, and other materials for internal and external soundness—then every part is checked again after each operation such as turning, grinding, cutting and heat treating. Thus Pacific-Western Inspection Departments serve the Aviation Industry by eliminating the causes of breakdowns and failures before they reach the field—saving you time and money.

GEARMAKERS—and ENGINEERS

Pacific-Western Gear make a complete line of gear reducers and actuators designed especially for the aircraft industry. Pacific-Western Actuators are available in two torque types; one type for limited rotation up to 120° at 6,000 in. lbs., another type for output speeds down to 100 rpm. at 5,000 in. lbs. torques. The jackscrew type is available with capacities to 20,000 lbs. screw load and strokes to 10 inches. Write for performance charts and technical data.

ILLUSTRATION SHOWS
Inspector in Western Gear plant checking gear shown on table for tooth form, dimension, and finish on optical comparator.

PACIFIC WESTERN
GEAR PRODUCTS

PACIFIC-WESTERN GEAR WORKS
[illegible]
Los Angeles [illegible]

PACIFIC-WESTERN GEAR & TOOL WORKS
[illegible]
San Francisco 3, California

ELECTRIC MUSCLES

FOR SUPERFORTRESSES!

LANDING FLAP ACTUATOR MOTORS · TAIL-SKID ACTUATOR MOTORS · RUDDER SERVO-MOTOR · CAMERA MOTORS · BOMB SIGHT GYRO-MOTORS · BOMB-BAY DOOR COMPRESSOR MOTORS · TURRET DRIVE MOTORS · AMMUNITION BOOSTER MOTORS · HEATER MOTORS · AILERON SERVO-MOTOR · AUTOMATIC PILOT GYRO-MOTORS · COWL FLAP ACTUATOR MOTORS · ELEVATOR SERVO-MOTOR · DEFROSTER MOTORS · FUEL PUMP MOTORS · MAIN LANDING GEAR ACTUATOR MOTORS · BOOSTER PUMP MOTORS

WESTINGHOUSE LONGER LIFE AIRCRAFT MOTORS...

FOR EVERY AIR-BORNE APPLICATION

1/6 H.P.

Westinghouse pioneered in the development of aircraft motors . . . in research, design, engineering. Using finest materials and manufacturing methods, Westinghouse motors for aircraft have kept pace with aeronautical progress. They are light in weight and small in proportion to their ratings. A wide variety of sizes and ratings are available to meet individual requirements.

•

1/4 H.P.

This totally-enclosed motor with brake (top) has an intermittent rating of ⅙ hp, 7500 rpm at 26 volts. Weight, 2 pounds, 6 ounces.

•

1 H.P.

This totally-enclosed fan-cooled motor (center) is rated ¼ hp continuous, 9800 rpm, at 27 volts. Weight, 4 pounds.

•

This open-type, blast-cooled motor (bottom) provides 1 1 hp continuously at 6000 rpm, 26 volts. Weight, 46½ pounds.

A big OK has been given to electrical operation of important functions aboard Allied bombers and combat planes . . . thanks to the high efficiency and dependability of electrical distribution, aircraft motors and generators. An important portion of rotating electrical equipment is supplied by Westinghouse. There are two basic reasons:

1. Westinghouse supplies a wide range of motors, generators, dynamotors and actuators. This equipment has been extensively tested in the Westinghouse high-altitude test chamber which reproduces accurately the conditions encountered by aircraft at altitudes as high as 50,000 feet.

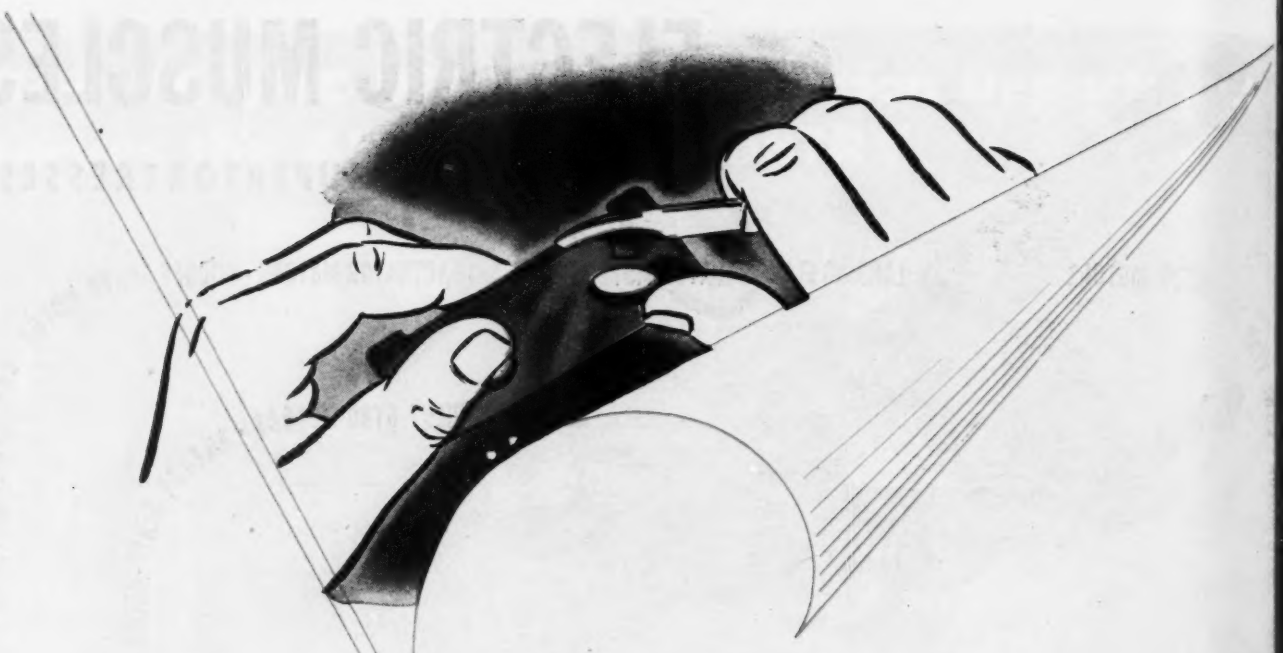
2. The high-altitude brush treatment . . . developed by Westinghouse . . . has tremendously increased brush life in the stratosphere. Under certain conditions ordinary carbon brushes wear away rapidly at stratosphere levels, because of the loss of a lubricating oxide film on the commutator. Westinghouse engineers developed chemical treatments for brushes that maintain this lubricating film.

From combat planes, which engage in dog fights at 40,000 feet, to huge bombers which must fly at high altitudes for many hours, Westinghouse has supplied a varied assortment of rotating apparatus. The experience and skill developed by decades of Westinghouse leadership in motor design are yours today to help solve any motor application problem. Call your Westinghouse office, or write Westinghouse Electric and Mfg. Co., Lima, Ohio.

J-03220

Westinghouse **AIRCRAFT MOTORS**

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE



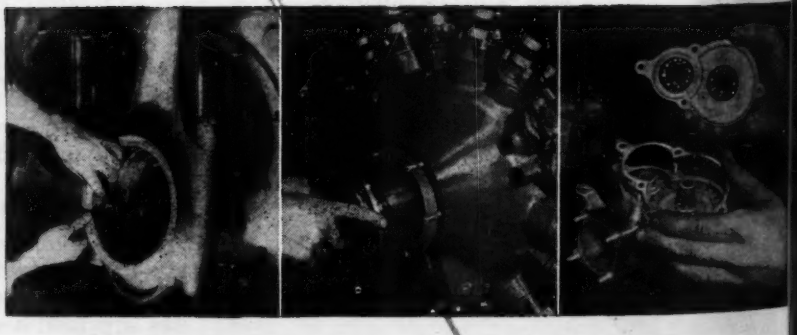
Have you looked into this saving in *ASSEMBLY?*

OF COURSE a skilled mechanic can machine solid brass to the uniform gauge of a Laminum shim... fitting machine parts to the same critical precision.

But when you can simply *peel* .002 or .003-inch laminations from the solidly bonded Laminum shim, will your costs stand the time for machining?

Write for the Laminum application photo chart illustrating scores of uses... from aircraft to diesels. Laminum shims are cut to your specifications. Shim materials for maintenance use are sold through industrial distributors.

Laminated Shim Company, Incorporated
80 Union Street • Glenbrook, Connecticut



it's **LAMINUM** — THE SOLID SHIM THAT *peels* FOR ADJUSTMENT

WITH A

MAHON

Hydro-Foam

Dust Collection System IN OPERATION

automatically deposited

UNDER WATER

the • SAFE • SURE • *Method of* Dust Elimination

Here is a pneumatic system of dust disposal that is completely automatic from intake to dust removal. Dust is picked up at the point of its inception . . . conveyed by ducts to Collector . . . where even the finer particles are permanently deposited *under water*, by means of the *patented* Mahon Foam Control. No moving parts, other than exhaust fan and sludge unloader. No spray nozzles, pumps or cloth screens. Nothing to clog, get out of order or be subjected to excessive wear. Let Mahon engineers show you what the superior *Hydro-Foam* method is accomplishing for others in your field . . . how it is effectively safeguarding both workers and work. Costs nothing to have the facts laid before you.

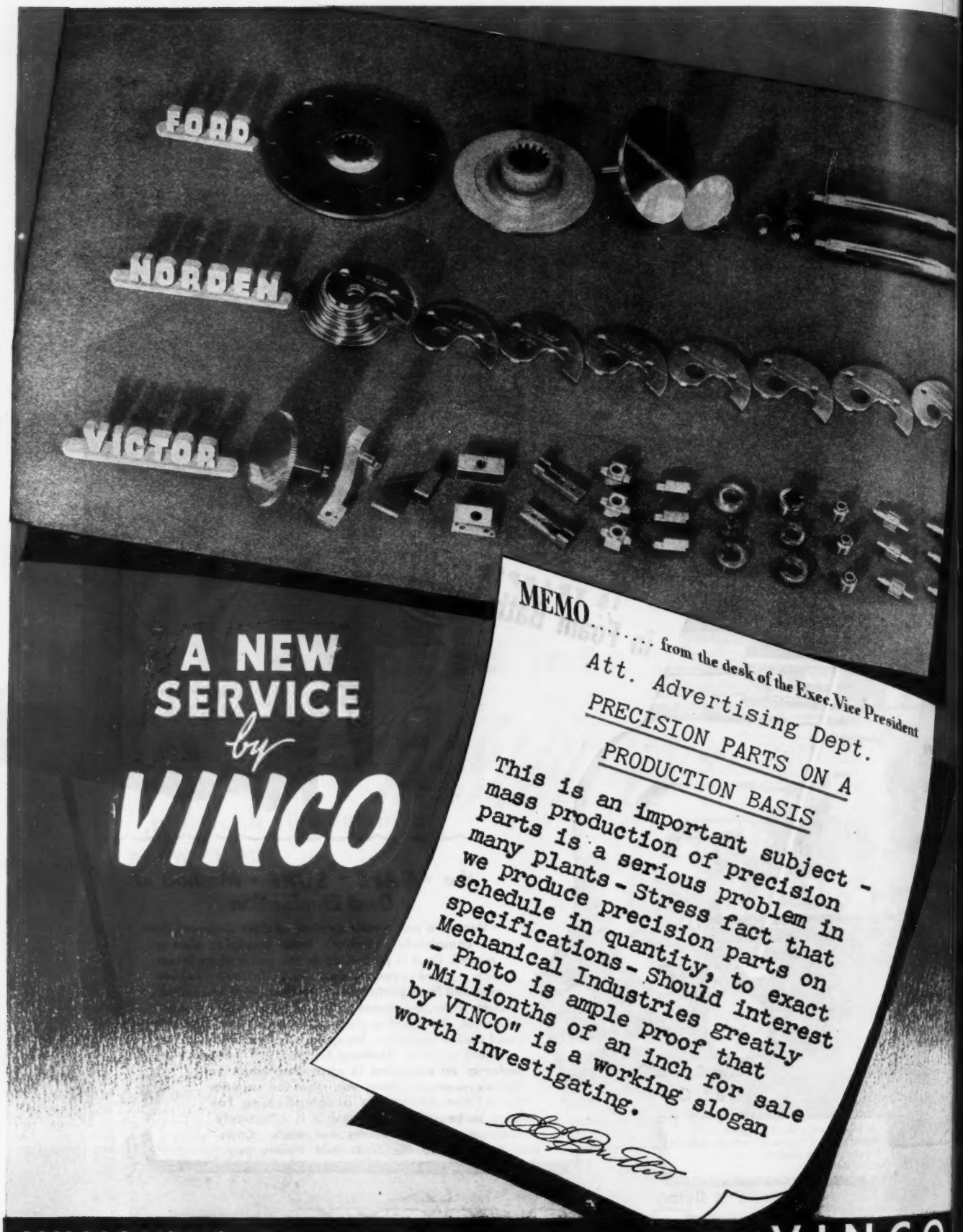
REMOVES THE DUST FROM INDUSTRY

In this installation, 24 Mahon *Hydro-Foam* units effectively remove dust from machining operations on aircraft propellers.

THE R. C. MAHON COMPANY

DETROIT 11 — CHICAGO 4

Designers and Manufacturers of Metal Cleaning Machines, Rust Proofing Machines, Hydro-Filter Spray Booths, Ovens of All Types, Filtered Air Supply Systems, Hydro-Foam Dust Collectors—and Many Other Units of Special Production Equipment—Including Complete Finishing Systems.


FORD
NORDEN
VICTOR
A NEW SERVICE by VINCO
MEMO..... from the desk of the Exec. Vice President
Att. Advertising Dept.
PRECISION PARTS ON A PRODUCTION BASIS
This is an important subject - mass production of precision parts is a serious problem in many plants - Stress fact that we produce precision parts on schedule in quantity, to exact specifications - Should interest Mechanical Industries greatly - Photo is ample proof that "Millionths of an inch for sale by VINCO" is a working slogan worth investigating.

MILLIONTHS OF AN INCH FOR SALE BY VINCO

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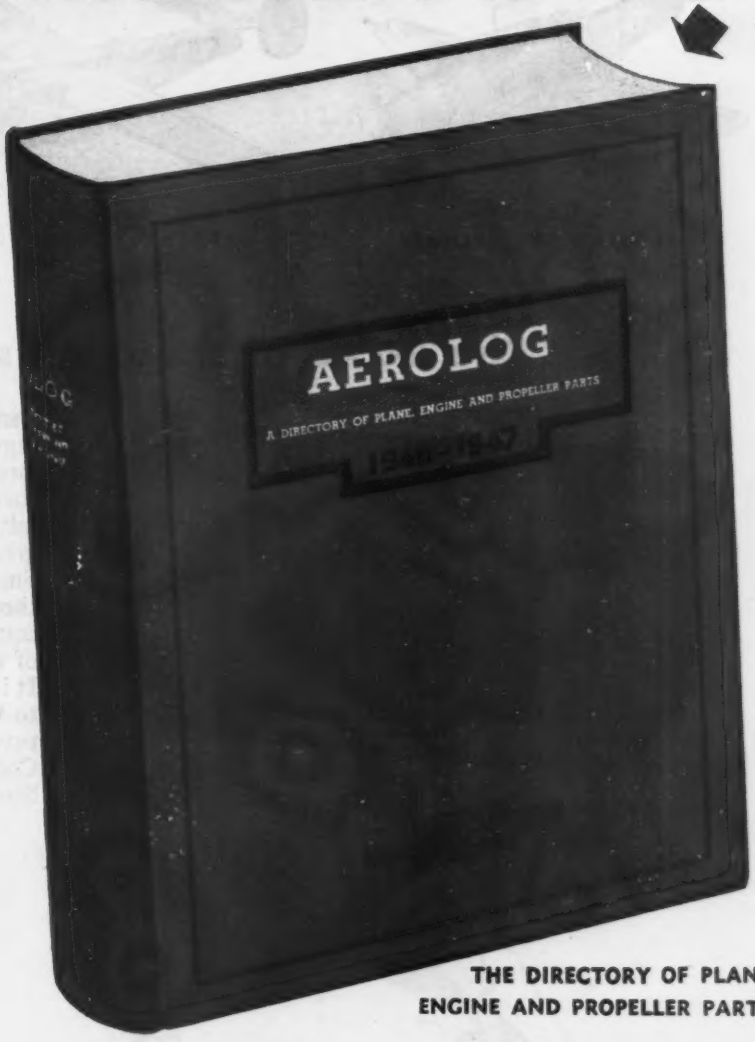
Semi-Automatic Hydraulic Spline and Gear Grinder • Optical Master Inspection Dividing Head • Involute Checker • Angle Tangent to Radius Dresser • Index Plates • Precision Vises • Sine Bars • Straight-side Spline, Serration Spline, Involute Spline and Helical Spline Plug and Ring Gages • Thread Plugs, Rings and Setting Plug Gages • Spur and Helical Master Gears • Munition Gages • Propeller Hub Gages • Built-up and Special Gages • Gear Rolling Fixtures • Spline and Index Fixtures • Hydraulic Power, Control, Utilization and Distribution Units • Engineering, Design and Development.

Attention Manufacturers

List Your Plane, Engine and Propeller Parts and Parts Distributors In . .

uture and Postwar sale of Airplanes, ngines and Propellers will depend on e quick and easy accessibility of re-lacement parts and service facilities ecessary to keep planes in the air. As n important contribution to private fly-g and maintenance, list your plane, ngine and propeller parts and parts dis-ributors in Aerolog, the directory of lane, engine and propeller parts.



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AEROLOG Will Be Placed in Every Airport and Flying Field In The U. S. A., CANADA and MEXICO

Aerolog is <u>not</u> a magazine or catalog; carries no display advertisements. It is the ONLY EXCLUSIVE DIRECTORY OF PLANE, ENGINE AND PROPELLER PARTS. It will contain photographs, basic data and parts drawings; complete parts lists and ordering information; complete list of official Distributors of Parts for all Planes, Engines and Propellers described in Aerolog.

Now, every airport and flying field operator in the U.S.A., Canada and Mexico can quickly locate his nearest distributor of parts for any plane.

FOR SPACE RATES, RESERVATIONS AND COMPLETE INFORMATION ADDRESS

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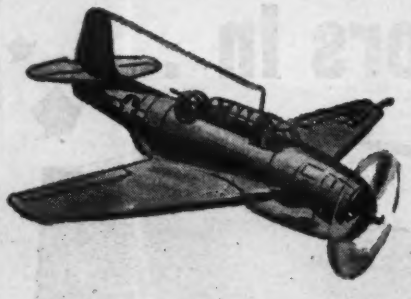
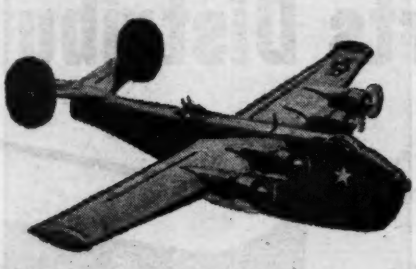
THE STECK COMPANY

AUSTIN, TEXAS

These U. S. Navy Planes Carry Collins Autotune Transmitters



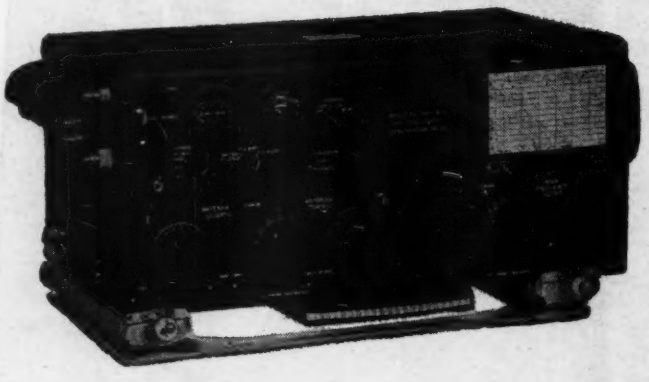
GRUMMAN TBF AVENGER



PB2Y-3 CORONADO

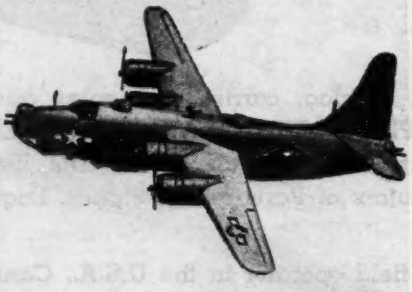
MARINE CORPS PBJ MITCHELL

The voice of thousands of Navy fliers



THE COLLINS ATC Autotune transmitter is regulation equipment for most two-place-and-larger types of Navy aircraft. It is the military successor of Collins airborne Autotune transmitters which were adopted by several of the great commercial airlines years before the war. Since Japan struck, the Navy has ordered many thousands. In advanced design and rugged construction, today's ATC reflects the lessons of war learned in every quarter of the world. It is a foretaste of the reliability and efficiency to be expected of Collins by commercial and private users after victory. Collins Radio Company, Cedar Rapids, Iowa; 11 West 42nd Street, New York 18, N. Y.

CURTISS SB2C-1 HELLDIVER



PB4Y-2 PRIVATEER

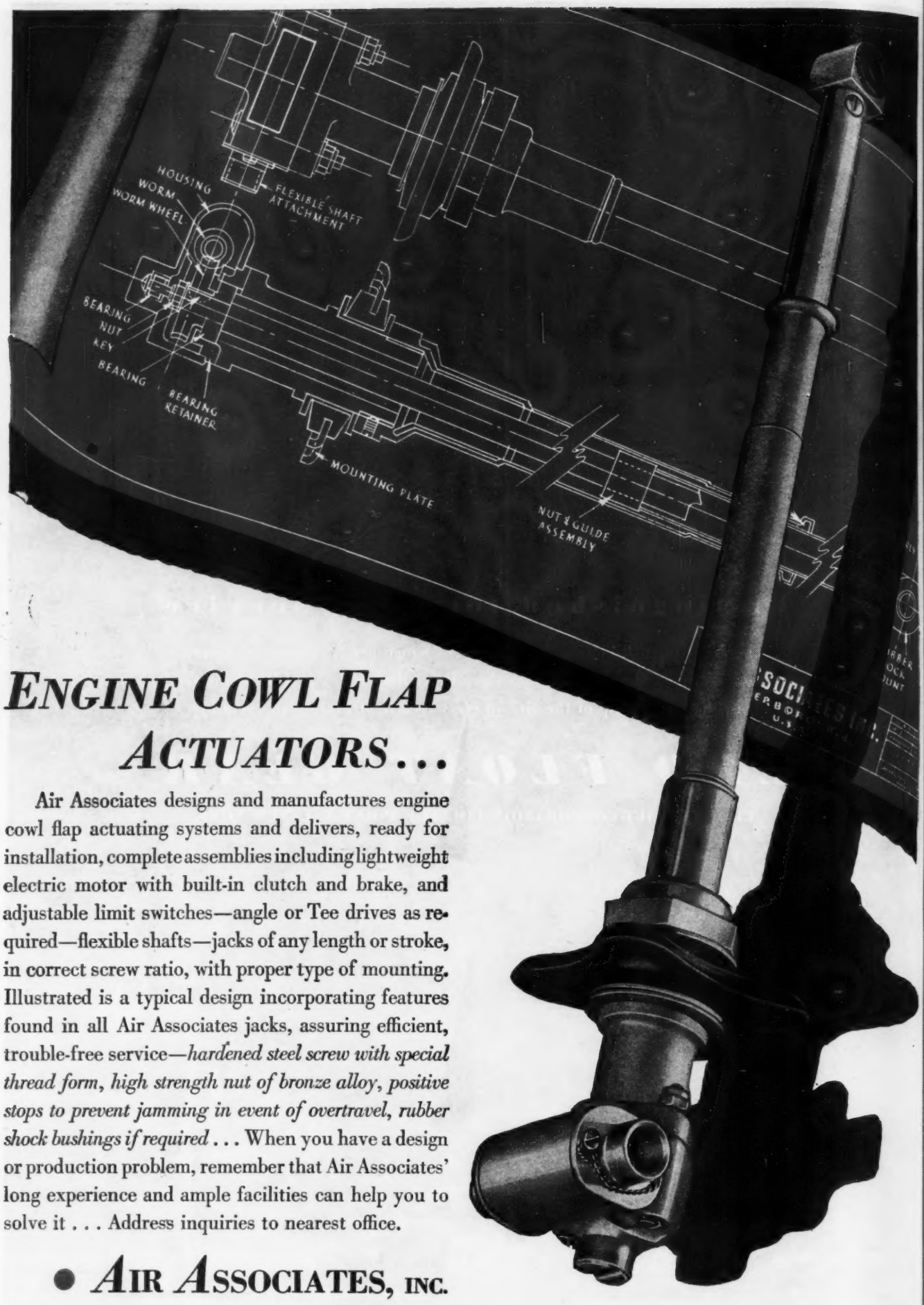
MARTIN PBM-3D MARINER

ARMY E NAVY

IN RADIO COMMUNICATIONS, IT'S . . .

COLLINS

Distinguished for Long Service
The Edo-equipped Vought-Sikorsky OS2U Kingfisher . . . veteran of countless spotting and rescue missions since Pearl Harbor . . . is still the indispensable "mercy ship of the air" in every theatre of over-ocean operation.
EDO FLOAT GEAR
EDO AIRCRAFT CORPORATION, COLLEGE POINT, L. I., NEW YORK



ENGINE COWL FLAP ACTUATORS...

Air Associates designs and manufactures engine cowl flap actuating systems and delivers, ready for installation, complete assemblies including lightweight electric motor with built-in clutch and brake, and adjustable limit switches—angle or Tee drives as required—flexible shafts—jacks of any length or stroke, in correct screw ratio, with proper type of mounting. Illustrated is a typical design incorporating features found in all Air Associates jacks, assuring efficient, trouble-free service—*hardened steel screw with special thread form, high strength nut of bronze alloy, positive stops to prevent jamming in event of overtravel, rubber shock bushings if required* . . . When you have a design or production problem, remember that Air Associates' long experience and ample facilities can help you to solve it . . . Address inquiries to nearest office.

• AIR ASSOCIATES, INC.

TETERBORO, N. J. . . . *BRANCHES:* CHICAGO, DALLAS, LOS ANGELES . . ENGINEERS AND MANUFACTURERS OF AIRCRAFT SPECIALTIES . . SUPPLIERS OF ALL TYPES OF MATERIALS TO THE INDUSTRY SINCE 1927

PRESSTITE Compound Seals All Metal Joints in Army's Giant M4 and M6 High Speed Tractors

A Partial List of Industries for Which Presstite has successfully Developed Special Sealing Compounds:

For the Aircraft Industry:

Sealers for Integral Fuel Tanks
Fuselage Seams
Drop-off, Expendable Fuel Tanks
Gun Turrets
Synthetic Glass
Instruments
Intercoolers
Air Ducts
Insulating Dissimilar Metals
Seaplane Floats

For the Refrigeration Industry:

Sealers for Domestic and Commercial Refrigerators
Bonding and Sealing Low Temperature Insulation in Refrigerated Rooms

For the Railroads:

Sealers for Insulating, Soundproofing, and Weatherproofing of Railway Cars—Sealing Car Windows and Spot Welded Seams

For the Building Industry:

Roof Coatings, Caulking and Waterproofing Compounds

For the Radio Industry:

Sealers for Radio Panels and Cases, Coil Impregnation—Many Communication Equipment Applications

For the Automotive Industry:

Special Adhesives and Sealers

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Sealers for Jointing Sewer Pipes
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Miscellaneous:

For Glazing Greenhouse Windows
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Ammunition Paints
Plus Many Special Products for the Army and Navy

Our Engineering, Technical, and Laboratory facilities are at the service of any industry with a sealing problem.

M4 Prime Mover in severe muddy terrain.

Placing Presstite Sealing Compound (Type SS-50) around engine inspection hole at rear of hull.

Applying Type SS-50 Sealer on closure between cab roof and front.

Weighing 18 and 38 tons, respectively, and manufactured by the Tractor Division of Allis-Chalmers, these units are the last word in power and speed in military tractors. Used to haul big guns over all types of terrain, these massive vehicles must be thoroughly sealed against moisture, mud, and water.

Presstite Sealing Compound Type SS-50, in extruded form, is used to seal all metal joints in the hulls, as well as to caulk front closure plates, bumper supports, and all joints between cab roof and side panels.

Again Presstite Sealing Compounds have proven their ability to stand up under the most exacting standards and the hardest conditions of use—just as they have successfully met the rigid requirements of military aircraft construction.

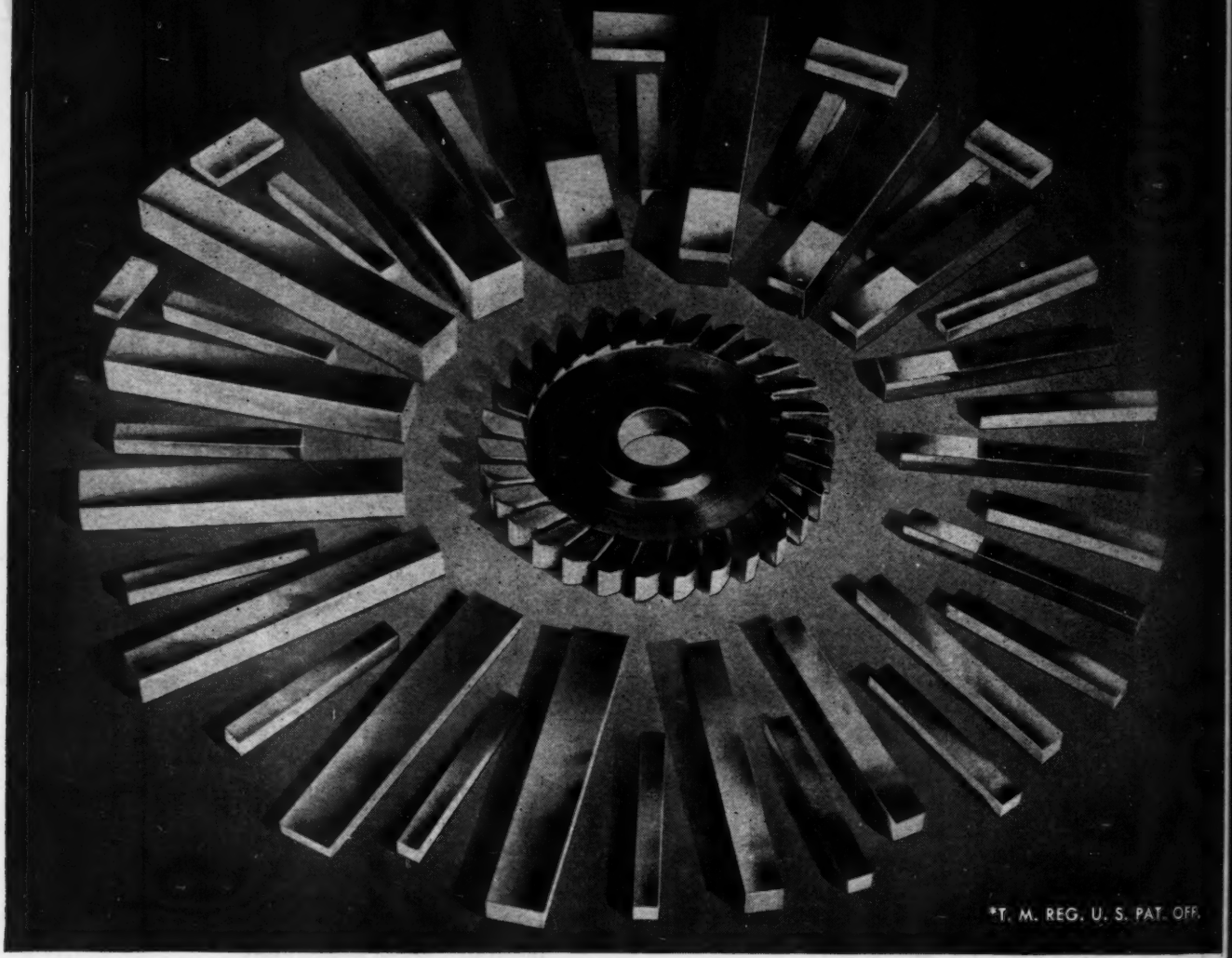
To industry at large, Presstite offers the same engineering skill and specialized experience that has developed so many varied types of sealers for wartime use. We are ready to work with you and your engineers on *any* sealing or coating problem. Just send us your requirements—now.

PRESSTITE SEALING COMPOUNDS

PRESSTITE ENGINEERING COMPANY
3910 Chouteau Avenue, St. Louis 10, Missouri

BORCOLOY*

FAST CUTTING FERROUS TOOLS



*T. M. REG. U. S. PAT. OFF.

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THE CENTRIFUGALLY CAST BORON COBALT ALLOY

FOR "MIDDLE-RANGE" MACHINING OPERATIONS

Extensive research in the field of cutting alloys has resulted in the centrifugally cast ferrous alloy that incorporates the superior Hardness of heat treated steel (Rockwell up to C-71) with the "Red Hardness" of Cobalt, and the "Wear and Abrasion Resistance" of Boron.

Tools of BORCOLOY cut tough and heat treated materials with feeds and speeds greater than those ordinarily obtained on "bottle-neck" production jobs —particularly so on the special aircraft and ordnance materials that present such a challenge today.

In order to meet these grueling demands with maximum efficiency, may we suggest you try BORCOLOY TOOLS under your most unfavorable conditions, and let their ability speak for themselves to remove more metal faster, with finer finish, at less cost per unit.

GENERAL AIRCRAFT EQUIPMENT, INC.

Tool Division; South Norwalk, Conn.

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Save Money

WITH P & N SOCKETYPE CABLE TERMINALS

1. SAVES CABLE—SMOOTHER, EASIER Full use of cable—no doubling back. Streamlined design—no coils, bulges or sharp ends to foul or come loose.

EYE TYPE for 1/16" to 1" cables

3. STRONGER THAN ANY CABLE Stamped and drawn to close dimensions of 4130 alloy steel, with strength factor greatly in excess of cable.

FORK TYPE for 1/16" to 1" cables

2. EASIER TO INSTALL—ANY TYPE OF CABLE Socketype terminals are swaged* to the cable—the quickest, safest and most expensive method known.

4. CABLE KINKING ELIMINATED Cable end fits smoothly in terminal socket. Cable may turn when load is off—no turning action when load is on.

P&N

ESTABLISHED 1922

POULSEN & NARDON, INC.

Terminal Box 2398 • Los Angeles 54, California

* If swaging equipment is not available, we can furnish die for punch press swaging. For further information, call your P & N Distributor listed below, or write for new folder.

Poulsen and Nardon

Poulsen swage tools on cable swaging available to industry personnel.

Los Angeles Aviation, Inc.
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Alameda Airport, Oakland-on-San Leandro, California

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Poulsen Aircraft Products Co.
1411 4th Avenue
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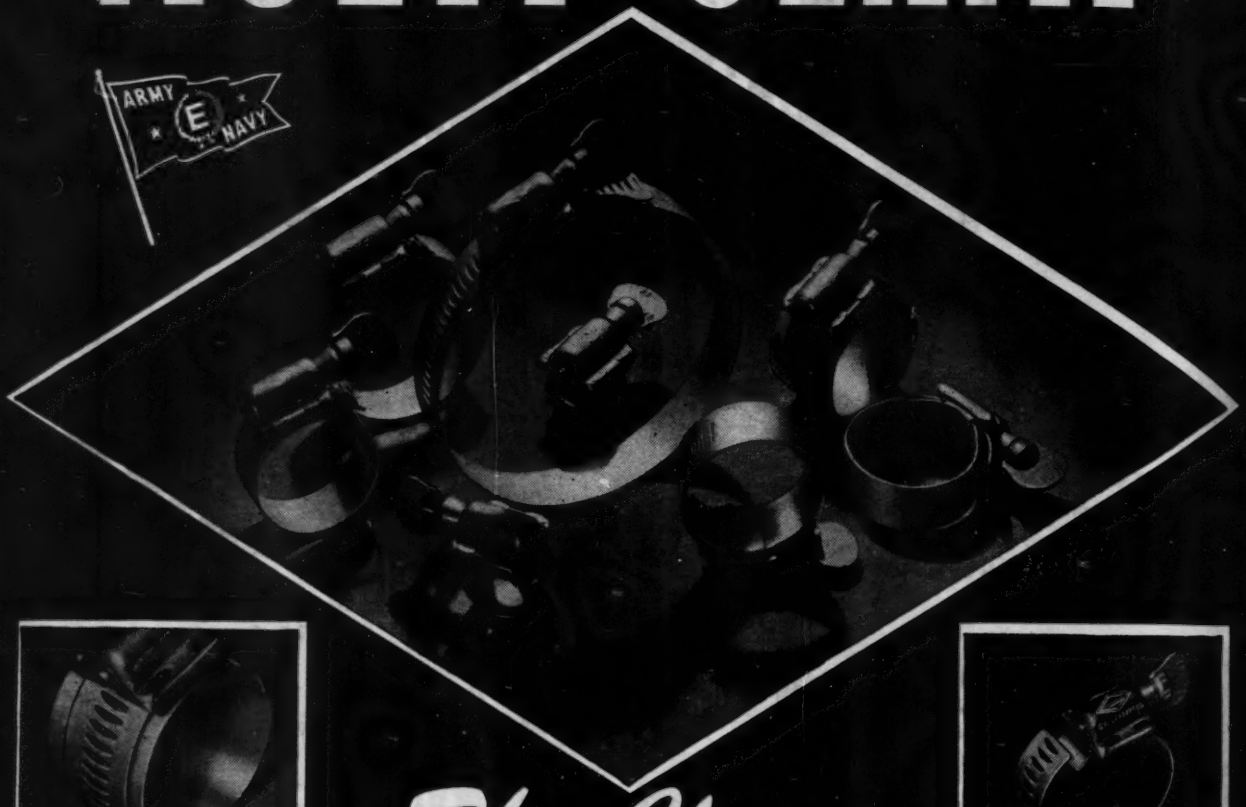
DIAMOND G MULTI-CLAMP



Individually designed for Special Applications

Easy to Install—no disassembling

Single size, smooth non-serrated contact

Double Safety Feature—mechanically held and welded

The Clamp of a thousand uses...

Here's a new clamp that meets the needs of many industries . . . a clamp that solves scores of problems quickly and economically!

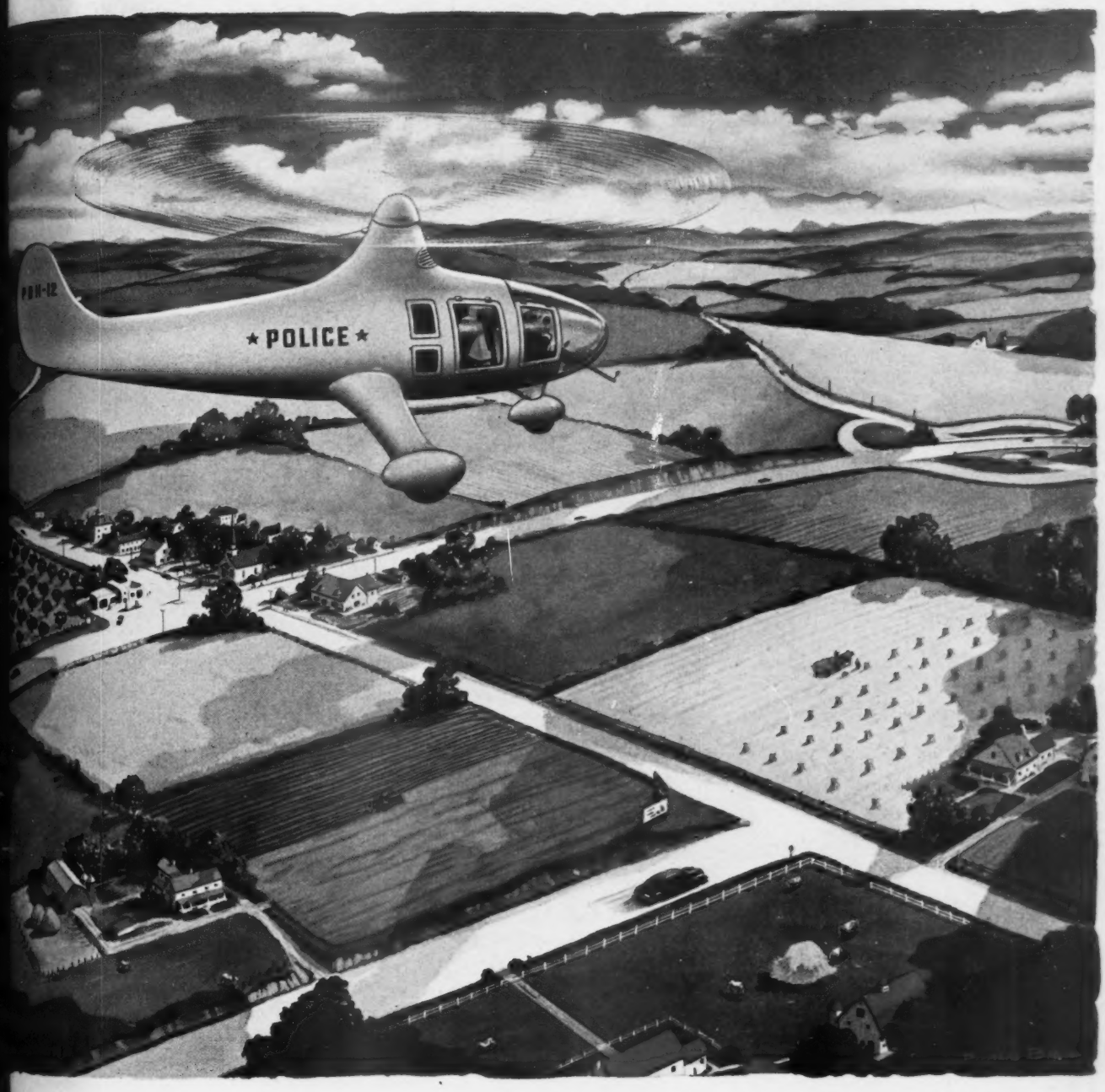
The new Diamond G MULTI-CLAMP instantly FITS and HOLDS rubber hosing, metal pipe, tubing, cables and other equipment in a vise-like grip. No wrench, no screw-driver, no disassembling necessary. The patented worm-type self-locking screw assures uniform instant adjustment. Each standard MULTI-CLAMP covers a wide range of sizes and adjustments. Continuous "gear-action" solid band prevents leakage or unequal pressure at any point!

Made of fine carbon steel, rust-proof and cadmium plated, the Diamond G MULTI-CLAMP meets Army-Navy specifications AN-FF-C 406a. It can be re-used many times and is practically indestructible. Mechanically held and securely welded . . . a double safety feature! For special purposes, various types of inserts, extra wide bands of metal, plastic or rubber are available.

See the MULTI-CLAMP in action. Sample on request. One test will convince you . . . for automotive, hydraulic, pneumatic, electronic, aviation, electrical or general plant applications.

GEORGE K. GARRETT CO., INC.
1421 CHESTNUT STREET, PHILADELPHIA 2, PA.

DIAMOND G PRODUCTS



Calling all Helicopters

"Calling all helicopters," may be expected to supplement the familiar phrase "calling all cars," *postwar*. For the helicopter is ideally suited to police patrol, traffic, and transportation needs.

Used for aerial reconnaissance, it can quickly spot and overtake fleeing criminals on highways. And, when equipped with necessary armament and loud-speaker equipment, it could if necessary, cope with such criminals, without other police assistance.

For highway patrol and traffic work, the helicopter is also highly useful. Capable of hovering over intersections as well as patrolling congested areas and crowded highways, it is ideally adapted to the specialized needs of traffic observation and control.

On riot calls, too, the helicopter might save lives by saving minutes. For it avoids the delays and hazards of surface traffic, and is easily capable of transporting as many as 12 fully equipped men.

At McDonnell, *right now*, we're working to the limit of our capacity, to turn out more planes, parts, and plastics for war. But when peace comes, we'll be ready to discuss specialized police helicopters . . . to help maintain peace and aid in the protection of lives and property in your city.

McDONNELL *Aircraft Corporation*

Manufacturers of PLANES · PARTS · PLASTICS ★ SAINT LOUIS - MEMPHIS ★

THE BLACK WIDOW

In cold, catalog language, the Northrop P-61 is "an airplane designed for the interception and destruction of hostile aircraft in flight during periods of darkness or poor visibility."

But to many a high-flying Heinie and Jap, this twin-tailed beauty with the kiss of death is an unseen nightmare. Her sleek blackness blends with the night . . . her sensitive "feelers" seek out the enemy with deadly accuracy . . . suddenly, she closes in, spitting hell from 20 mm. cannon and .50 cal. machine guns.

She's a tough lady, this Black Widow — largest, most powerful fighter ever built. And she's more than proved her mettle in darkened skies over every battlefront.

We at Chandler-Evans feel a kinship with this plane . . . because our fuel pumps are among those chosen for use with her huge Pratt & Whitney 2000 h.p. engines. And it is the superb performance of planes like this that make every Chandler-Evans man and woman determined to keep on producing the finest fuel pumps possible — *and in quantity.*

CHANDLER-EVANS CORPORATION
SOUTH MERIDEN, CONNECTICUT, U. S. A.

CECO

CARBURETORS
FUEL PUMPS
PROTEK-PLUGS

Don't SWAB HOT DIE SURFACES BY HAND...

Install a LINCOLN HEAVY DUTY SPRAY SYSTEM

speeds production – saves expensive dies

The schematic drawing above, illustrates how the Lincoln Hot Die Lubrication System can be applied to forging presses. This modern system provides a fast, economical way to spray hot die graphite lubricants by direct pressure.

With the Lincoln System the compound is dispensed direct from original container to the nozzles which spray the surfaces. No waste. No mess. It assures even distribution, preventing sticking, crazing and cracking of expensive dies. Saves compound and eliminates mess, industrial hazards and accidents.

The famous Lincoln Heavy-Duty Pump for dispensing graphite compounds direct from original containers.

Mail Coupon for Complete Information

Today, with production on hot die forgings at an all time high, many plants have installed these Lincoln Systems. The installation is simple and pump can be located at a point remote from press if desired. Our engineers will gladly make recommendations. The coupon at right is for your convenience.

LINCOLN ENGINEERING COMPANY
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We are interested in Spraying Hot Die Lubricants. Have your representative call.

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*Title*_____

*Company*_____

*Address*_____

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B154

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LINCOLN ENGINEERING COMPANY

Pioneer Builders of Engineered Lubricating Equipment

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LINCOLN

The CONE AUTOMATIC MACHINE COMPANY sees many GOOD THINGS AHEAD

It is reported that . . . . . .

Ball bearings, for precision equipment, are now made with outside diameter as small as two millimeters. *Science News Letter.*

get ready with CONE for tomorrow

The first cotton crop to be harvested entirely by machine has recently been reported. The result seems to be a lower grade of cotton offset by reduced cost. *Time.*

get ready with CONE for tomorrow

Postwar automobile wheel rims are to be wider, or about three-fourths of the tire width. *National Wheel Rim Assn.*

get ready with CONE for tomorrow

The combined use of the electron microscope and the three-dimensional vectograph is making possible better observation of the structure of metals and consequent improvement of alloys. *Dow Chemical Company.*

get ready with CONE for tomorrow

A new product is intended to seal the spaces between spot welds and make a continuous liquid-tight joint. *Presstite Engineering Co., St. Louis.*

get ready with CONE for tomorrow

A new system of aircraft engine lubrication is claimed to supply an adequate flow of oil as high as 45,000 feet. *Penn. State College and Sharples Co., Phila.*

get ready with CONE for tomorrow

The number of persons employed in individual research laboratories just about doubled in the ten years ending in 1940. *G. Edward Pendray, Asst. to President, Westinghouse Electric & Mfg. Co.*

get ready with CONE for tomorrow

A new process of adding carbon black to liquid rubber latex will, it is hoped, reduce the cost of tires and add to their service. *General Tire & Rubber Company.*

get ready with CONE for tomorrow

It is claimed that one of the new rechargeable flashlight batteries will outlast 400 of the usual dry cell type. *B. F. Goodrich Co.*

A new 4 by 6 foot "tectonic" map of the United States shows the complete geologic structure of the country and is said to be the first of its kind ever published. *American Assn. of Petroleum Geologists.*

get ready with CONE for tomorrow

A new device called the "Odograph" automatically makes a map, in any scale, of a road while being carried in a fast-moving automobile. *U. S. Army Engineer Corps.*

get ready with CONE for tomorrow

A jet propulsion drive for torpedoes has recently been patented. *Science News Letter.*

get ready with CONE for tomorrow

A portable electrostatic air cleaner is used to precipitate the smoke produced by welding. *Westinghouse Electric & Mfg. Co.*

A manual of instruction in the making of aerial "highway signs" for the guidance of aircraft has just been published. *Civil Aeronautics Administration.*

get ready with CONE for tomorrow

The Combined British Astronautical Societies have designed a "space ship" in which they propose to send three men to the moon in about 48 hours. *Electronic Markets.*

get ready with CONE for tomorrow

An automobile manufacturer is already planning the assembly-line production of helicopters. *Nash-Kelvinator Corp.*

get ready with CONE for tomorrow

A new material for shoe soles is said by the maker to be lighter and more durable than leather and resistant to oil and water. *B. F. Goodrich Co.*

get ready with CONE for tomorrow

More than 80,000 farmers obtained government priorities to electrify their farms, in 1943, as a means of increasing food production. The 1944 total will probably reach 120,000. *EMPIC No. 8.*

This machine cuts its own weight in metal in four days

3½" 6-Spindle Cononetic

To produce the part shown, 6 pounds of chips — over a sixth of a ton of metal per hour — were removed from WD1314 bar stock.

CONE

AUTOMATIC MACHINE CO., INC. ✻ WINDSOR, VERMONT, U.S.A.

LANDING GEAR . . .
tough as steel, soft as air!
Heat treated, alloy steel gives Aerols* super strength to withstand the terrific impact of landings. Yet their rugged cylinders are filled with soft, resilient air which, together with oil, effectively cushions and absorbs the landing shock.
Pioneered and perfected by Cleveland Pneumatic almost 20 years ago, Aerols are an established aircraft advancement — their reliability has been proved on every size of plane, in every climate, on every terrain.
Illustrated is the Curtiss C-46 Commando, a leading military transport plane destined for wide postwar commercial use.
THE CLEVELAND PNEUMATIC TOOL CO.
AIRCRAFT DIVISION • CLEVELAND 5, OHIO
Help Finish the Fight! Buy MORE War Bonds and Stamps!
AEROLS*
*PNEUMATIC-HYDRAULIC (AIR-OIL) SHOCK ABSORBING LANDING GEAR

NOW WELD "DIFFICULT" METALS QUICKLY AND UNIFORMLY

—WITH THE NEW G-E INERT-GAS-SHIELDED ARC-WELDING PROCESS

IF your production depends upon the fabrication of aluminum, magnesium alloys, stainless steels, inconel, copper, cold-rolled steel, or other "hard-to-weld" metals or alloys, you will find that this *new* welding process offers unlimited possibilities for increasing both the rate and the quality of your output.

Welds of these "difficult" metals made with an arc that is shielded by either helium or argon are strong and excellent in appearance, and are generally made without flux.

During G.E.'s extensive research and testing of this new process, special methods and equipments were developed for important war jobs which included:

The welding, without flux, of aluminum as thin as 0.040 inch and as thick as 1/2 inch. The welding of copper end rings and rotor bars for induction motors, copper backing for X-ray tubes, stainless-steel water jackets for electronic tubes, aircraft exhaust manifolds, magnesium ignition harnesses, and the welding of fernico to steel for electronic tube seals.

If you have important war jobs that could be turned out faster and to higher standards when welded with this new G-E inert-gas-shielded process, we can now supply you with light and heavy manual electrode holders, and automatic welding heads for use with either helium or argon. Both of these gases are now readily available.

Get in touch with your G-E welding distributor for recommendations as to the inert-gas-shielded equipment and methods best suited for your production needs—or write General Electric Company, Schenectady 5, N. Y.

Buy all the BONDS you can—*and keep all you buy*

GENERAL ELECTRIC

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Another FIRST for *Federal* Selenium Rectifiers

FEDERAL'S INVERTER FAILURE RELAY

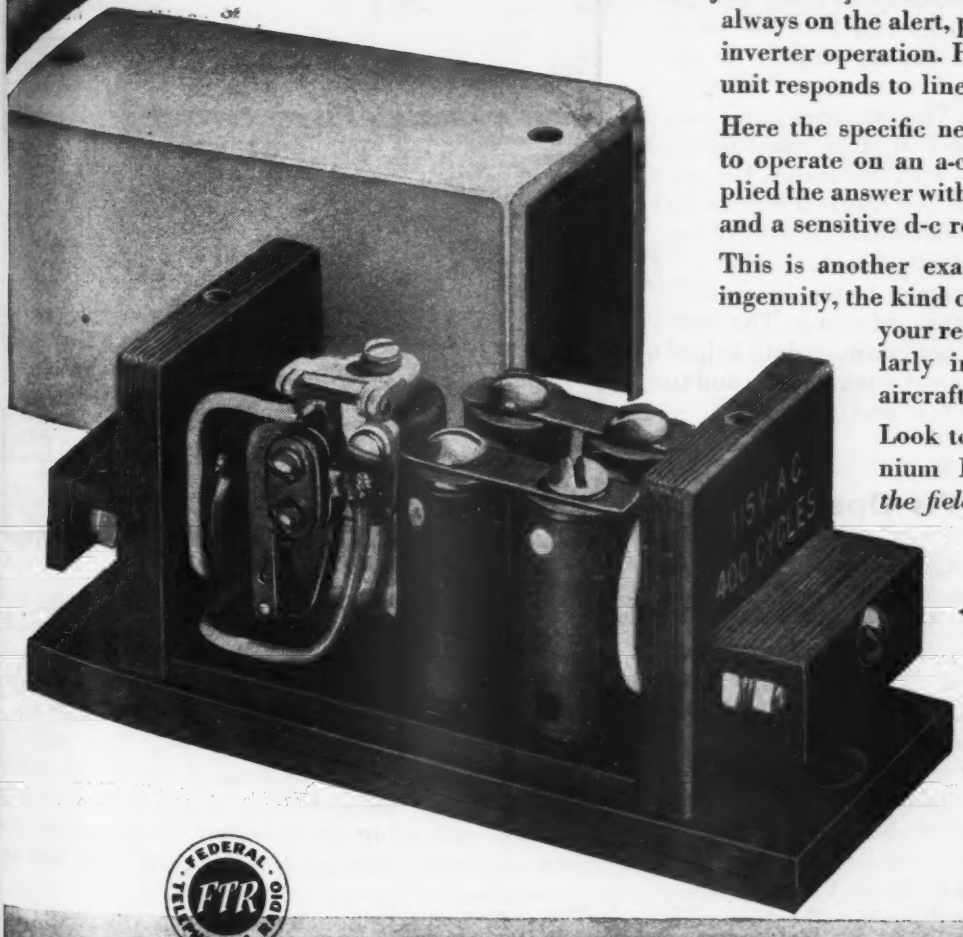
In a B-29 high over Tokyo . . . or a Clipper winging across the Atlantic—an instrument panel lamp flashes timely warning of a-c power failure.

This is the job done by Federal's Inverter Failure Relay . . . always on the alert, providing a constant check on inverter operation. Highly sensitive, this compact unit responds to line variations as low as *one* volt.

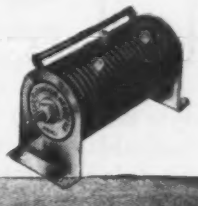
Here the specific need was for an accurate relay to operate on an a-c line. Federal engineers supplied the answer with a Federal Selenium Rectifier and a sensitive d-c relay.

This is another example of Federal engineering ingenuity, the kind of ingenuity you need to solve your rectification problems—particularly in the new higher frequency aircraft a-c power systems.

Look to Federal for the best in Selenium Rectifier equipment, *first in the field and standard for industry.*



Federal's Inverter Failure Relay, shown actual size, operates on 115-volts, 400 cycles a-c, the relay contacts carrying approximately one ampere at 28 volts.



FEDERAL TELEPHONE & RADIO — FTR

Federal Telephone and Radio Corporation

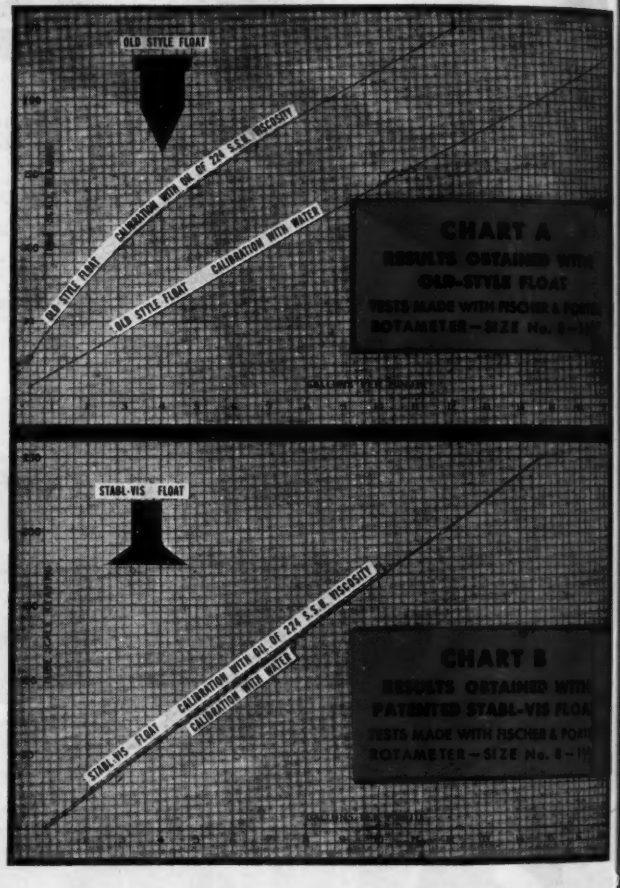
How one aircraft manufacturer obtained fast, accurate production flow tests!

A production bottle-neck was broken when instantaneous flow readings of hydraulic pump capacities were accurately obtained.

A manufacturer of hydraulic pumps for aircraft was laboriously testing the capacity of his finished pumps by means of weigh tanks because every flow meter that he knew about showed an unallowable error when the viscosity of his hydraulic test oil changed. Then he visited a large AAF air base and saw them using a Stabl-Vis rotameter for checking hydraulic pumps. He was amazed to see the speed with which pumps could be tested with it, and was really galvanized into action when he also learned that the meter was immune to viscosity and density changes in the Servo oil being used.

He arranged to test a Stabl-Vis rotameter in his own Plant, and it performed so well that he immediately equipped all of his test stands with this meter. He now obtains *instantaneous*, accurate flow rate readings, and a production bottle-neck has been broken because of the time saved in testing his finished product.

He later used the Stabl-Vis meter to do the research work on a new and vastly improved pump. The completeness and accuracy of his performance data helped him to accomplish his development work quickly and to get prompt acceptance of his new unit.



How the Stabl-Vis Operates

The Stabl-Vis rotameter is an area-type meter, using a precision tapered tube and free-moving float. The patented Stabl-Vis float has a scientific shape, designed to change sinuous flow to turbulent flow, with the result that viscous drag on the float body is overcome. It can also be made of materials that cause it to compensate for changes in fluid density. The sketches show the sinuous flow obtained with the old style plumb-bob float and the turbulent flow given by the Stabl-Vis float. The curves in Chart A show that the old style plumb-bob float introduces a calibration error of over 30% in going from water to oil of only 224 S.S.U. With the Stabl-Vis float, the curves for these two fluids are *identical*, proving that the change in viscosity has not affected the Stabl-Vis calibration.

Because of this remarkable characteristic, there are now thousands of Stabl-Vis meters in daily use, installed in aircraft manufacturing plants all over the world. They have been used to measure every conceivable fluid for aircraft services, including gasoline, diesel fuel, kerosene, "lube" oils, hydraulic fluids, coolants, oxygen, air, nitrogen, welding gases, inert atmospheres for heat treating furnaces, de-icer fluid, freon, water injection, blow-by gases, etc. The Stabl-Vis rotameter is obtainable as a direct or remote reading meter for use on the ground or in the plane. It may be flow rate indicating or recording or recording automatic-controlling. Integrators to give total flow are also available.

The Stabl-Vis rotameter theory is completely and interestingly told in our technical bulletin 98-Y. The various types of Stabl-Vis meters made especially for aircraft are described and well illustrated in bulletin 63-G. Aircraft engineers are welcome to these two catalogs without obligation — please write on your Company letterhead. Fischer & Porter Co., 305 County Line Road, Hatboro, Pa.

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THE war wouldn't wait—it has never waited—and today it's moving faster than ever. That's why, in the earliest, darkest days, the thousands of Americans at Jack & Heintz set their sights high on production of vital aircraft equipment—and will keep them there to the very end!

As the fighting turned slowly in our favor and now . . . island by island . . . mile by mile . . . draws closer to the enemy homelands, the tempo goes up and up and up. Doubled, trebled, quadrupled production assignments roll in . . . and the equipment rolls out at the same pace. Laboratory-precision products never before turned out in more than a few score are streaming to all fronts by the tens of thousands.

As a result of this intensive manufacturing experience, Jack & Heintz is today a group of several thousand time-conscious, production-minded people who have packed years of experience and know-how into months—broken all records in mass production of precision equipment—and kept faith with or beaten every deadline ever given them.

Just as this organization has kept pace with war, so it can help you in peace. For postwar competition won't wait, either—and the manufacturer who gets to market with *enough . . . on time . . . and right* will head the field.

JAHCO

JACK & HEINTZ
Incorporated

Jack & Heintz Inc., Cleveland, Ohio, manufacturers of aircraft engine starters, generators, gyro pilots, gyro flight instruments, magnetos, motors.

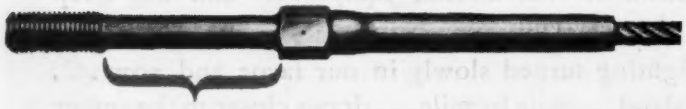
YOU GET THESE

ADVANTAGES

IN HARTWELL

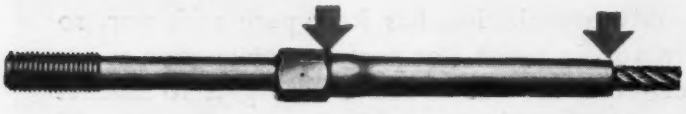
STAINLESS STEEL

SWAGED TERMINALS

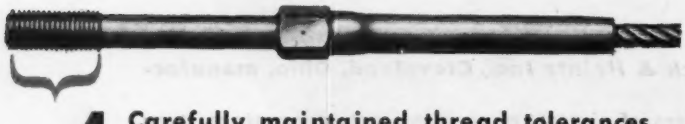


1 Shank tensile strength well in excess of breaking strength requirements. A new manufacturing process developed by Hartwell is turning out higher tensile strength terminals. Under the pull test, distortion is below specification allowance.

2 Improved swaging qualities. The process by which the tensile strength of the shank of Hartwell terminals is increased also safeguards their swageability.



3 Concentricity kept well within blueprint tolerances. Uniform wall thickness is maintained for the full length of the swaging end of Hartwell terminals. This assures perfect swaging and eliminates the danger of cable or terminal failure due to uneven stresses.



4 Carefully maintained thread tolerances. Automatic threading equipment, plus 100% inspection, assures a perfect thread, so essential to these highly stressed parts.

HARTWELL
SWAGING TYPE AIRCRAFT
CABLE TERMINALS
HARTWELL AVIATION SUPPLY CO.
3417 Crenshaw Blvd. Los Angeles
Dallas, Tex. • Detroit, Mich. • Kansas City, Kans.

5 Protection from our production line to yours. Hartwell stainless steel swaged cable terminals are packaged in die-cut cartons for protection in transit, for quicker and easier handling in the stockroom and at your swaging machines. On your next order, be sure to get the terminals that are *made right* and *shipped right!*

6 Complete line. Hartwell terminals are available in the following series: AN667, 2-10, inclusive; AN668, 2-10, inclusive; AN669, 2-10, inclusive, shorts, longs, rights and lefts. We also make terminals to your own drawings. All terminals are passivated by the hot process, and meet AN-T-2b specification. This specification enables you to take advantage of the superior quality of stainless steel terminals and use them with stainless steel, carbon steel cables, or wire rope.

Single source for 779 different aircraft production parts and tools

HARTWELL

AVIATION SUPPLY COMPANY

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TRUARC

RETAINING RING

U. S. PATENT RE. 18,144

● Waldes Truarc expands or contracts without distortion and without permanent set, fitting tight all around the groove. It offers important advantages over shoulders, nuts, collars, etc., for all thrust-load fixings in shaft and housing applications. It saves space, weight, assembly time and machining costs.

● Waldes Truarc presents a significant advance in retaining rings, well worth your thorough investigation. We will gladly furnish samples and full data for tests, upon request.

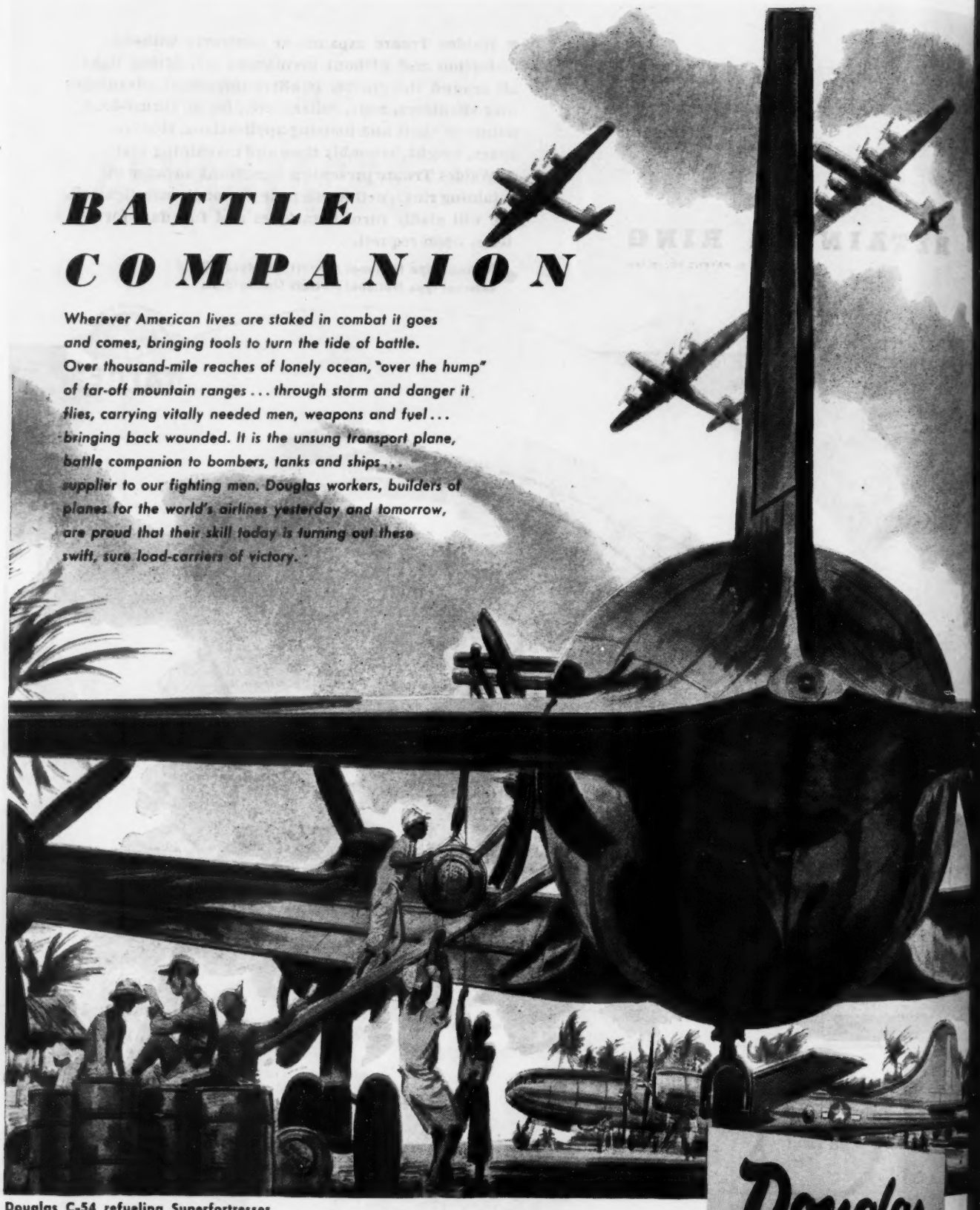
● Internal type National Aircraft Standard 50.
External type National Aircraft Standard 51.

WALDES KOH-I-NOOR, INC. Long Island City 1, N. Y.

Canadian Representatives: Prenco Progress & Engineering Corp., Ltd., 72-74 Stafford St., Toronto

BATTLE COMPANION

Wherever American lives are staked in combat it goes and comes, bringing tools to turn the tide of battle. Over thousand-mile reaches of lonely ocean, "over the hump" of far-off mountain ranges . . . through storm and danger it flies, carrying vitally needed men, weapons and fuel . . . bringing back wounded. It is the unsung transport plane, battle companion to bombers, tanks and ships . . . supplier to our fighting men. Douglas workers, builders of planes for the world's airlines yesterday and tomorrow, are proud that their skill today is turning out these swift, sure load-carriers of victory.



Douglas C-54 refueling Superfortresses

Douglas

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Fast, versatile and accurate, Barrett Brake Service Equipment eliminates every hazard arising from faulty brakes, makes lining last longer, cuts maintenance time and cost to a minimum.

Either portable or stationary, the ***Brake Drum Lathe*** machines, grinds and hones to mirror finish the toughest, hardest drums regardless of size, with the tires on or off.

Simple to use, light in weight, the ***Brake Dokter*** adjusts any brake assembly for clearance and faultlessly tailors for perfect shoe-to-drum contact---*right on the landing gear* or *in the shop*.

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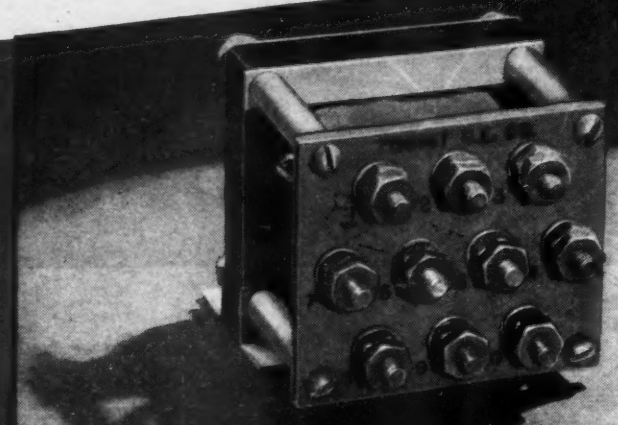
A NEW, MORE EFFICIENT WAY to operate and control 6-volt instrument lights



The G-E 400-cycle, single-phase aircraft transformer

Output: 30 va at 6 volts
Lightweight: 1 pound
Small: 2 1/4 by 2 5/32 by 3 3/16 inches

● This lightweight, compact transformer provides an efficient method of operating 6-volt aircraft instrument lamps, such as the MAZDA 328 midget. Its output capacity allows the simultaneous operation of 25 such lamps at full brilliancy. Two types are available: one with taps and one without.

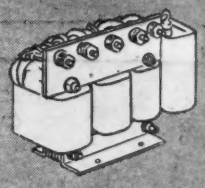
The secondary voltages of the unit with taps are: 6, 4.8, 3.94, 3.27, 2.78, 2.27, and 1.74. Each voltage reduction approximately halves the previous candlepower output of the lamps. Thus a preselection of light level is possible —ranging from a very low candlepower to full lamp brilliancy.

The unit not provided with taps has a 6-volt secondary. Any desired light level can be maintained (within the transformer's rating) by using a potentiometer to vary the transformer voltage smoothly.

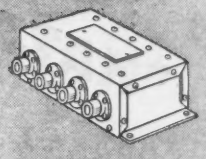
These new transformers are designed to resist moisture, heat, vibration, shock, and corrosion. They will operate successfully at any altitude, if sufficient ventilation is provided.

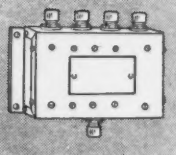
For further information ask for Bulletin GEA-4412. Or, for data on our complete line of aircraft transformers, write for Catalog GEA-4238. *General Electric Co., Schenectady 5, N. Y.*

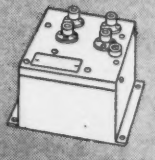
IMPROVE AIRCRAFT ELECTRIC SYSTEMS WITH THESE G-E TRANSFORMERS



3 to 1-phase, 2 to 3-phase, and 1 to 3-phase transformers







Transformers and ballasts for lighting indicators and instruments

Starting vibrators and ignition boosters

FOR THE WAR PLANES OF TODAY and THE COMMERCIAL PLANES OF TOMORROW

GENERAL ELECTRIC

light...compact...efficient

ELECTROL'S UNLOADER!

A dynamic contribution to the field of hydraulics, Electrol's Unloading Valve maintains working pressure in the hydraulic system of military aircraft. Designed for installation in very small space, the valve is astonishingly light and compact (actual weight of 6 gal. per minute valve, 1 lb. 3 oz.; 16 gal. per minute valve, 1 lb. 11 oz.). The Electrol Unloader assures dependable operation at temperatures from 65° below to 160° above.

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HYDRAULICS

ELECTROL INCORPORATED • KINGSTON, NEW YORK • HYDRAULIC EQUIPMENT

Add a passenger by saving weight with MAGNESIUM

Make a five-seater out of your four-seater plane! No radical changes in design are needed. Just take out unnecessary weight by using magnesium.

There are plenty of places where this can be done in tomorrow's personal planes . . . in doors, seats, oil tanks, wheels, instrument panels, and many accessory parts. Magnesium alloys will give the required strength and dependability, along with maximum savings in weight.

American Magnesium engineers are old hands at weight-saving. They will gladly help you employ magnesium to best advantage in cutting off needless pounds. Write Aluminum Company of America, Sales Agent for American Magnesium Products, 1713 Gulf Building, Pittsburgh 19, Penna.

MAGNESIUM MAZLO PRODUCTS

AMERICAN MAGNESIUM CORPORATION

SUBSIDIARY OF ALUMINUM COMPANY OF AMERIC

- Lighter, more compact designs save precious space and weight
- Simple, rugged construction withstands shock and vibration
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- Utterly dependable under all conditions
- Wide variety of types for every application.

FOR BETTER AIRCRAFT CONTROLS WE ARE THE "PERSONS" TO SEE

L. M. PERSONS CORPORATION

SAINT LOUIS 10, MISSOURI

Coming—for All Planes—Flying Horsepower

from new aviation Mobilgas!

☛ Great new super take-off, climb, range, load-carrying power for America's warplanes and commercial airliners . . . that's Flying Horsepower.

☛ It's an exclusive Socony-Vacuum development ...result of 12 years' research in catalytic cracking.

☛ It represents a $90,000,000 investment in new refineries and equipment...a $2,000,000 expenditure for research during the past two years alone.

☛ Fuel with this super power is flowing from 19 great Socony-Vacuum catalytic cracking units, greatest catalytic cracking capacity in the world.

☛ After Victory, these huge refining facilities will switch to full peacetime production . . . to assure Flying Horsepower for *all* planes!

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TUNE IN "INFORMATION PLEASE"—MONDAY EVENINGS, 9:30 E.W.T.—NBC

POWER TO WIN

"Grasshoppers" Over Manila

"Grasshopper" planes again made headlines when General Douglas MacArthur triumphantly marched back into Manila. In the skilled hands of versatile American pilots, these highly maneuverable, Continental-powered planes were first over the Philippine capital to spot artillery and fortifications.

The startling and brilliant feats of these "Grasshoppers" in many capacities are almost incredible.

Continental Red Seal Power — the Power to Win — is also contributing much as the motive force of Tanks, Tank Destroyers, Amphibians and many more types of vital fighting equipment on all fighting fronts.

ARMY E NAVY

Awarded to the Detroit and Muskegon Plants of Continental Motors Corporation for High Achievement

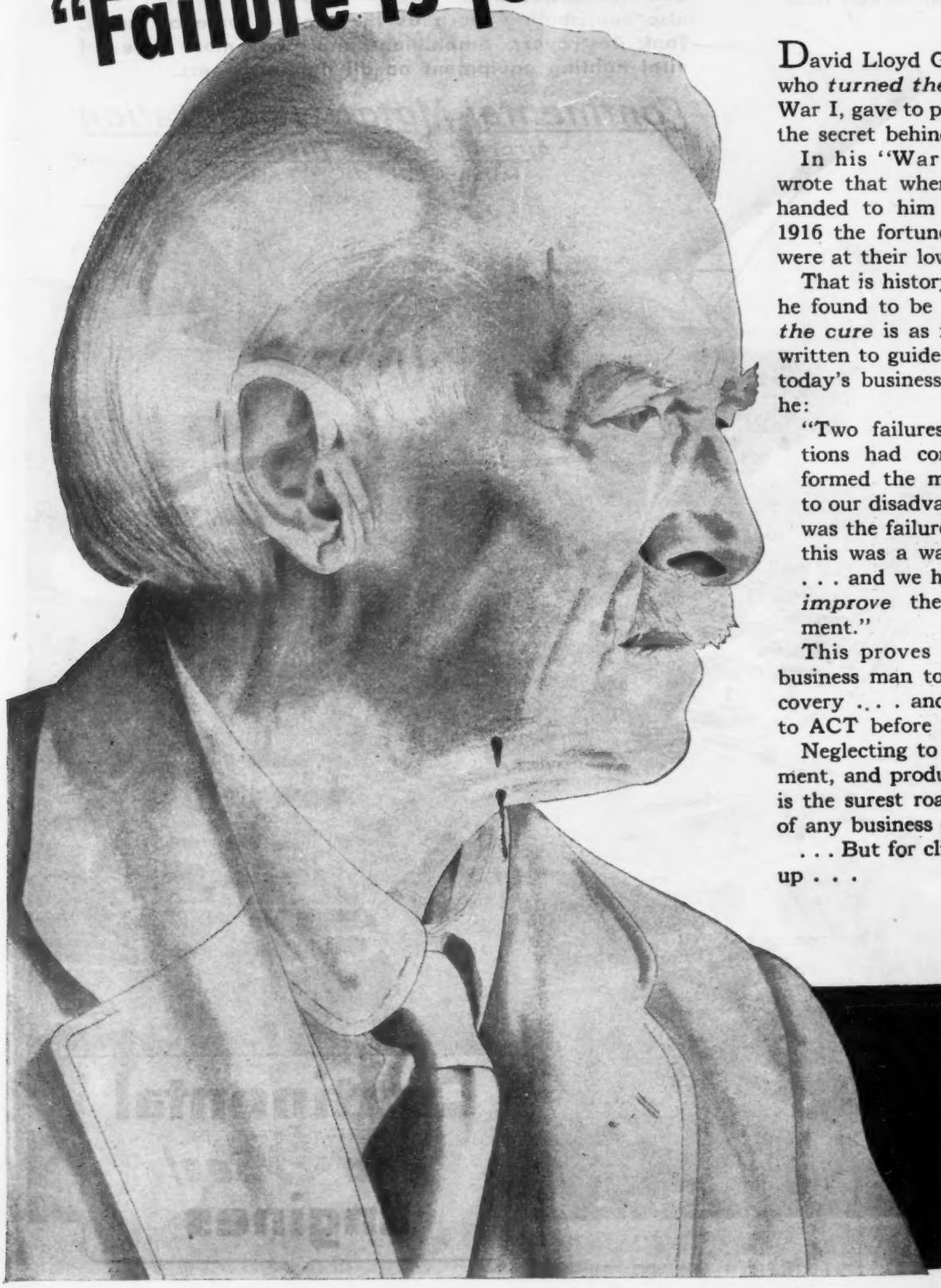
Your Dollars are Power, Too! Buy War Bonds and Keep Them!

Continental Motors Corporation
Aircraft Engine Division
MUSKEGON, MICHIGAN

Continental Red Seal Engines

then he said to himself

"Failure is just a symptom"



David Lloyd George, the man who *turned the tide* of World War I, gave to postwar planners the secret behind that turn.

In his "War Memoirs" he wrote that when the war was handed to him at the end of 1916 the fortunes of the Allies were at their lowest ebb.

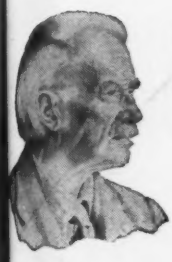
That is history . . . but what he found to be *the cause* and *the cure* is as fresh as though written to guide the strategy of today's business planners. Says he:

"Two failures on key questions had completely transformed the military position to our disadvantage. The first was the failure to realize that this was a war of machinery . . . and we had neglected to *improve* the Allied equipment."

This proves he was a good business man to make that discovery . . . and a better man to ACT before it was too late.

Neglecting to improve equipment, and production, and cost is the surest road to the valley of any business curve.

. . . But for climbing out, and up . . .



"IMPROVEMENT...the key," *he said*

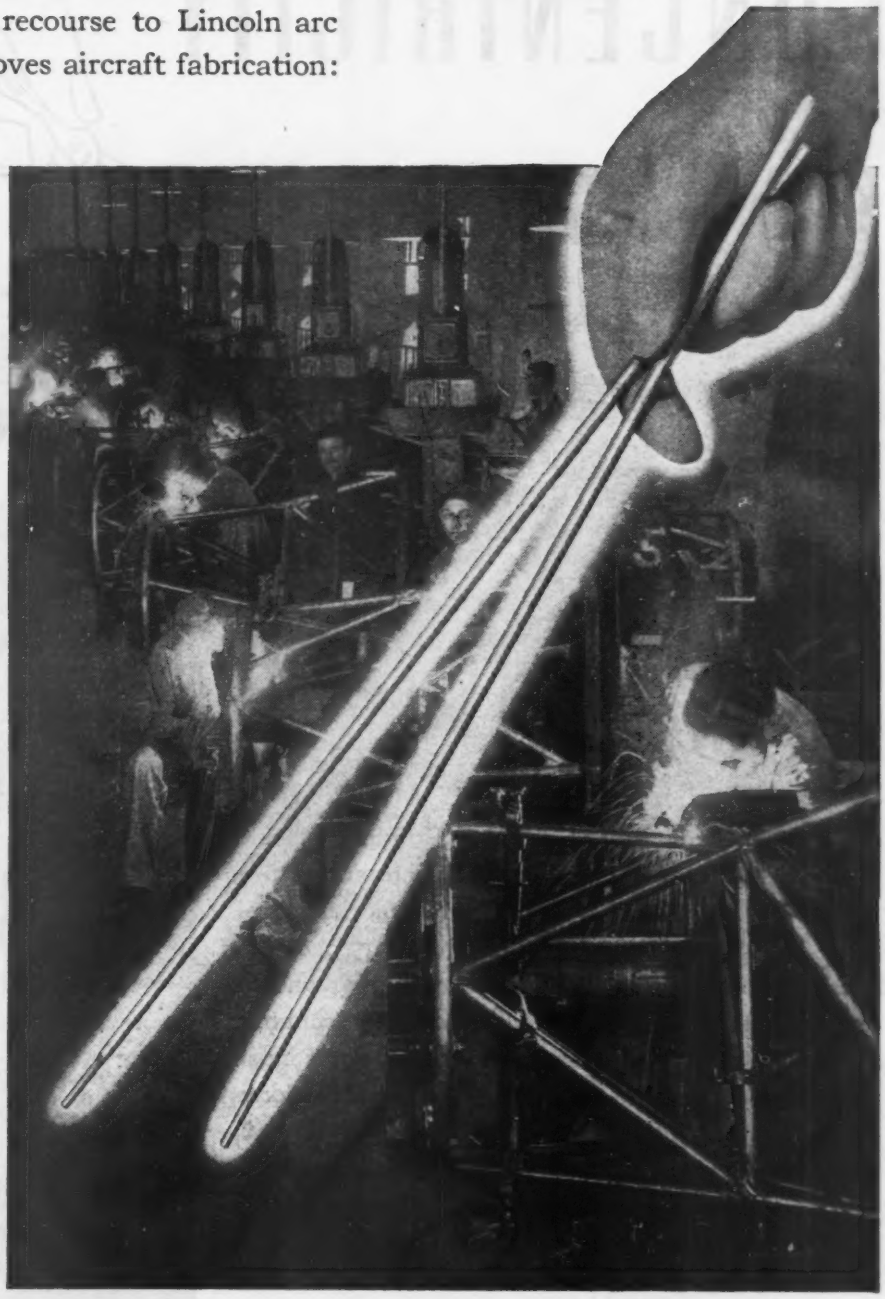
LOOK, how recourse to Lincoln arc welding improves aircraft fabrication:

LINCOLN "PLANEWELD" ...the key to better aircraft at lower cost

...ers report that this Lincoln Elec-...rode improves the welding of SAE ...130 and X4130 steel these ways:

...implifies arc handling . . . Quiet, ...mooth arc . . . easy to start and ...asy to maneuver. Extremely stable ...ven at very low current values.

...ives excellent fusion . . . Gets into ...orners. Washes up well on sides of ...oints. Makes extremely smooth, ...ound welds.



...abricating engine mounts with Lin-...oln "Shield-Arc Jr." Aircraft Weld-...rs and "Planeweld" Electrodes.

Full details and procedures given in the "Weldirectory," Bul. 402. Free on request.

THE LINCOLN ELECTRIC COMPANY • DEPT. X-1 • CLEVELAND 1, OHIO

America's greatest natural **recourse**

ARC WELDING

CONCENTRICITY

ABRASIVE Borolon and Electrolon Grinding Wheels run true and smooth without strain or chatter because exactness is basic in Abrasive Company manufacture. Typical of the accuracy maintained in every phase of production are the tests which check grinding wheels for concentricity and parallelism. To obtain running balance necessary for accurate grinding, bores must be exactly centered in true circular wheels of uniform thickness. From the selection of raw materials, and the manufacture of abrasive grains on through every stage of production, constant laboratory control with countless scientific tests and inspections govern Abrasive Company quality.

The illustration shows how Abrasive Company Grinding Wheels are "truth tested" with micrometer gauges on face and sides for concentricity and parallelism.

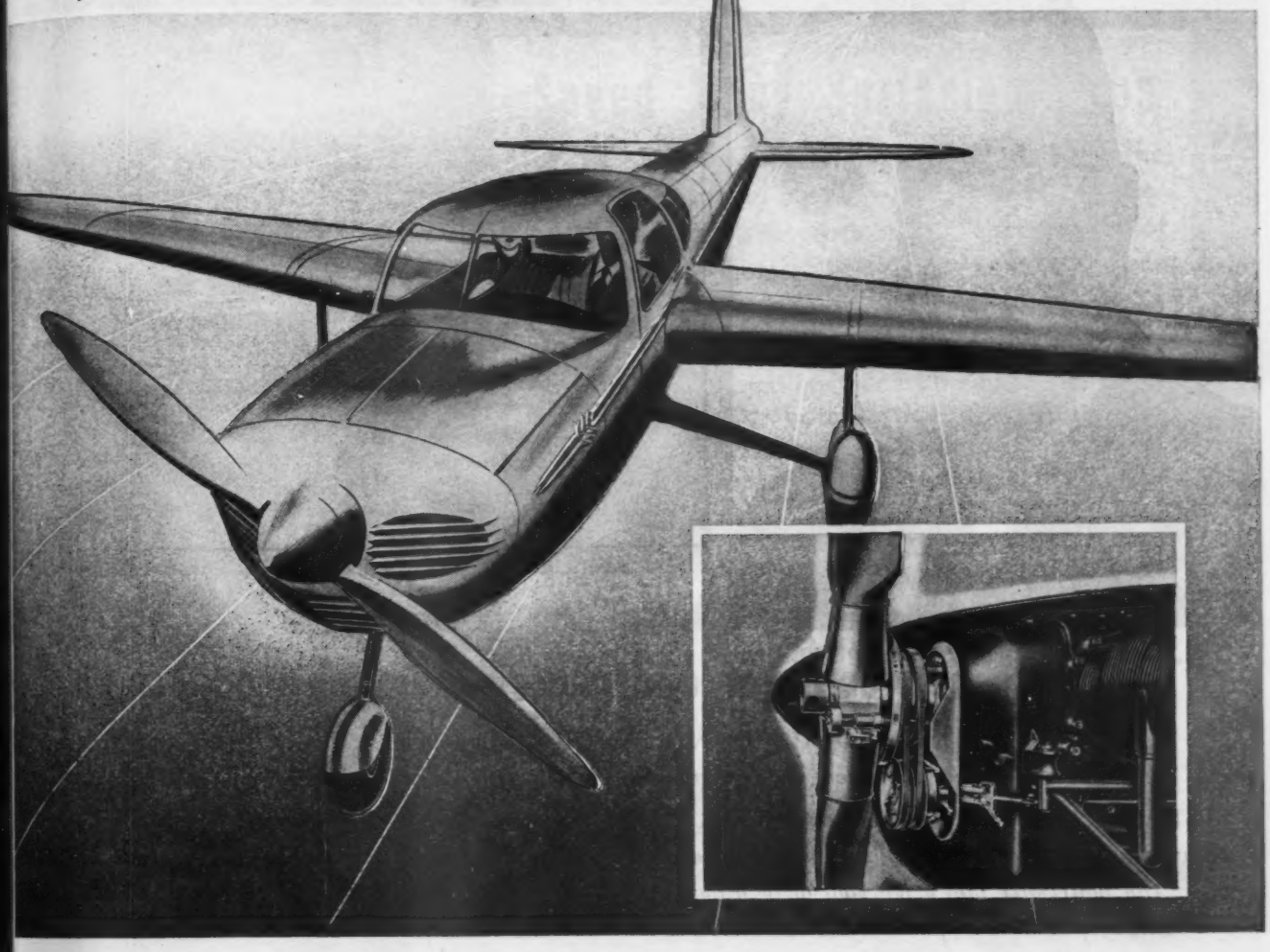
There is a Borolon (aluminum oxide) or Electrolon (silicon carbide) grinding wheel, mounted point or wheel to meet the selective service requirements for grinding, cutting, snagging and finishing every type of material. Abrasive Company distributors carry a wide variety of wheels and can be helpful in recommending grains, grades and bonds to produce the best results for specific grinding jobs.

abrasive Company

Division of Simonds Saw and Steel Company

ABRASIVE COMPANY • PHILADELPHIA • • DISTRIBUTORS IN ALL PRINCIPAL CITIES

Forget that larger engine and extra tank!



ISO-REV
CONSTANT SPEED
propellers

As shown by their exclusive use on high performance military and commercial aircraft, *selective rpm constant speed propellers* have superseded other types. They permit maximum utilization of available horsepower and optimum aerodynamic propulsive efficiency.

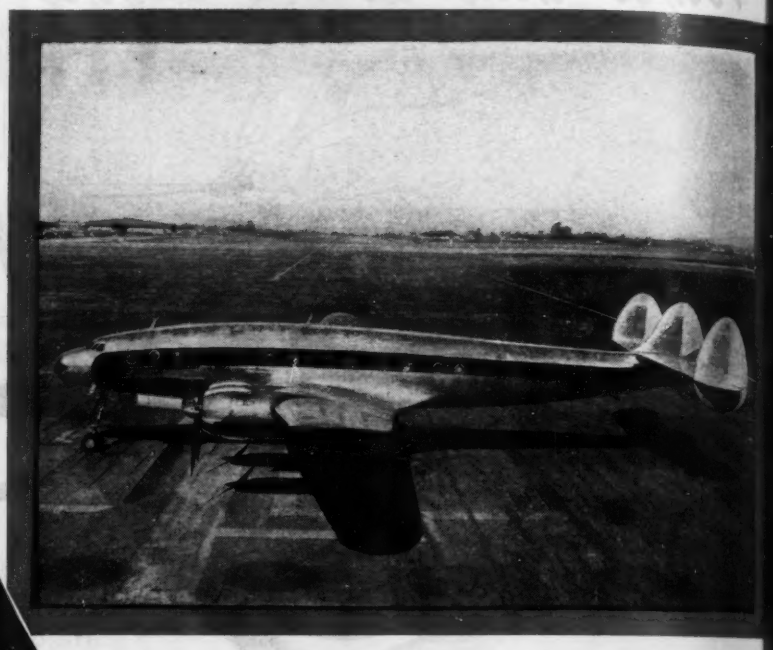
Only the unique operating principle of the *ISO-REV Constant Speed Propeller* inexpensively brings the many advantages of *true constant speed* operation to the personal airplane. Its application is equivalent to the installation of a larger engine and extra fuel tanks.

A booklet describing the principle of ISO-REV operation is yours for the asking.

"ISO—equal, alike, the same, uniform"
Webster

AIRCRAFT SPECIALTIES DIVISION
THOMSON INDUSTRIES, INC.
Formerly Known as ZIMMER-THOMSON CORPORATION
29-05 Review Avenue, Long Island City 1, New York

This is the twenty-second of a series of statements by aviation's leaders on THE SHAPE OF FLYING TO COME



"The pause between war and peace—Aviation's opportunity"

by CAPTAIN E. V. RICKENBACKER

President and General Manager, Eastern Air Lines, Inc.

"JUST AFTER THE WAR, *there will be a transition between two air ages—in which our war-built aviation industry can power-dive into a blackout or be airborne to new heights of peacetime opportunity. That's the time to guard against taking a grasshopper's-eye view of our resources of trained airmen and manufacturing techniques.*

"Then our airline planners should look far ahead. An interdepartmental government board consisting of representatives of the Army, Navy, State Department, Post Office and other agencies might do well to investigate overseas air facilities built by America during the war. And a unified Army and Navy Transport Command should continue this country's air operations, carrying not only military, relief, rehabilitation personnel and cargo, but also commercial passengers, mail and express.

"A large part of the 3,000,000 Army and Navy-trained pilots, mechanics, navigators, meteorologists, and other specialists could thus remain employed in their chosen fields until the private aviation industry could absorb them. The future of these men and women, and millions more, depends on how fast private aviation and government agencies move—in this breathing spell between war and peace."

Best and quickest way to turn Aviation's war-born advances into peacetime progress is to sell them *first* to America's "test-pilot" market—the thousands of air-minded men and women who already own and fly planes, the executives who travel regularly by air, the shippers who use air transport.

The charter members of this "test-pilot" market are listed on the circulation galleys of TIME. *For* TIME*'s 1,178,009 families are aviation's top postwar prospects. (And 214,000* TIME *families have one or more members in The Air Corps who will air-condition them even more, come the peace.) More than 32,000* TIME *readers own or have owned a private plane; more than 400,000 say they hope to own one some day.*

Next time you travel by air, see how many of your fellow-passengers are reading TIME. For wherever air-minded people fly, TIME flies too. And TIME is their favorite magazine by a margin of 7 to 1 over the runner-up.

Believing that the ideas of aviation's leaders are always of interest to the aviation industry,
TIME here gives them wider circulation
in the name of

AVIATION'S SILENT PARTNERS

TIME

THE READERS OF TIME

NORTON DISC WHEELS . . .

Speed Many Surfacing Jobs

GRINDING with Norton Resinoid Discs is the quickest and easiest way to do many surfacing jobs in airplane production. These discs not only remove metal quickly but leave a surface that often needs little or no further machining.

Norton Resinoid Discs are available in all the sizes and types of mountings necessary for all makes of disc grinders—for both vertical spindle and horizontal spindle machines—in Alundum abrasive for steel and malleable iron—in Crystolon abrasive for aluminum, magnesium, brass, bronze and gray iron. Norton Discs are also available in vitrified and silicate bonds.

Your Norton abrasive engineer will be glad to give you the specifications for your particular jobs.

NORTON COMPANY, Worcester 6, Mass.

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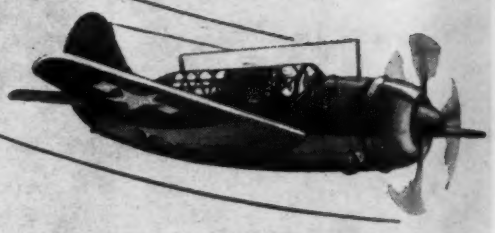
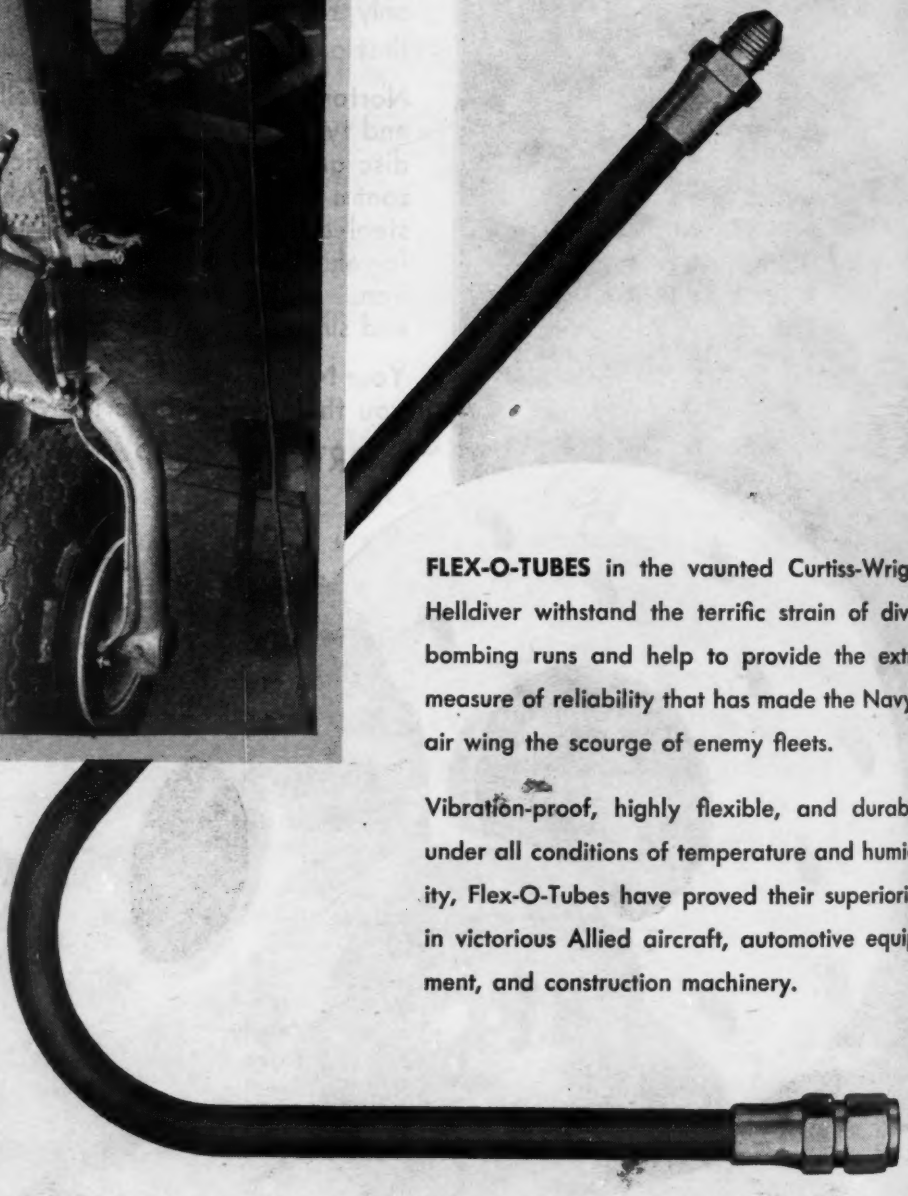
NORTON ABRASIVES

HELLDIVERS MUST STRAIN



Landing gear of Curtiss-Wright Helldiver showing Flex-O-Tube assembled for hydraulic brakes. (Photo courtesy Canadian Car & Foundry Co.)



FLEX-O-TUBES in the vaunted Curtiss-Wright Helldiver withstand the terrific strain of dive-bombing runs and help to provide the extra measure of reliability that has made the Navy's air wing the scourge of enemy fleets.

Vibration-proof, highly flexible, and durable under all conditions of temperature and humidity, Flex-O-Tubes have proved their superiority in victorious Allied aircraft, automotive equipment, and construction machinery.

Let Flex-O-Tube Engineers, with many years of experience in designing hose assemblies for specific applications, assist you in your wartime and postwar problems.

THE **Flex-O-Tube** COMPANY

LAFAYETTE at 14th AVE.,
DETROIT 16, MICHIGAN
Offices: CHICAGO · FORT WORTH
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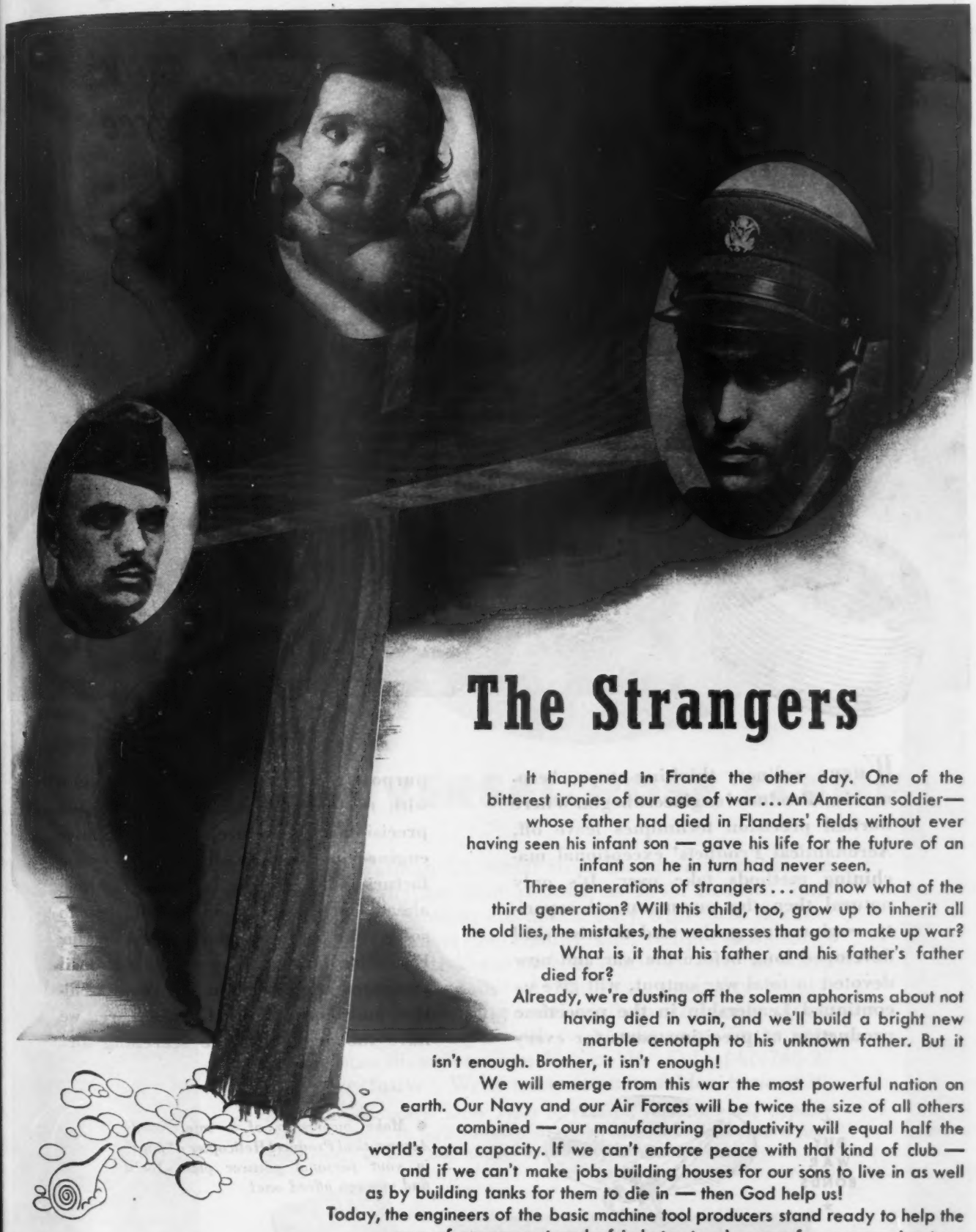


The Strangers

It happened in France the other day. One of the bitterest ironies of our age of war . . . An American soldier— whose father had died in Flanders' fields without ever having seen his infant son — gave his life for the future of an infant son he in turn had never seen.

Three generations of strangers . . . and now what of the third generation? Will this child, too, grow up to inherit all the old lies, the mistakes, the weaknesses that go to make up war? What is it that his father and his father's father died for?

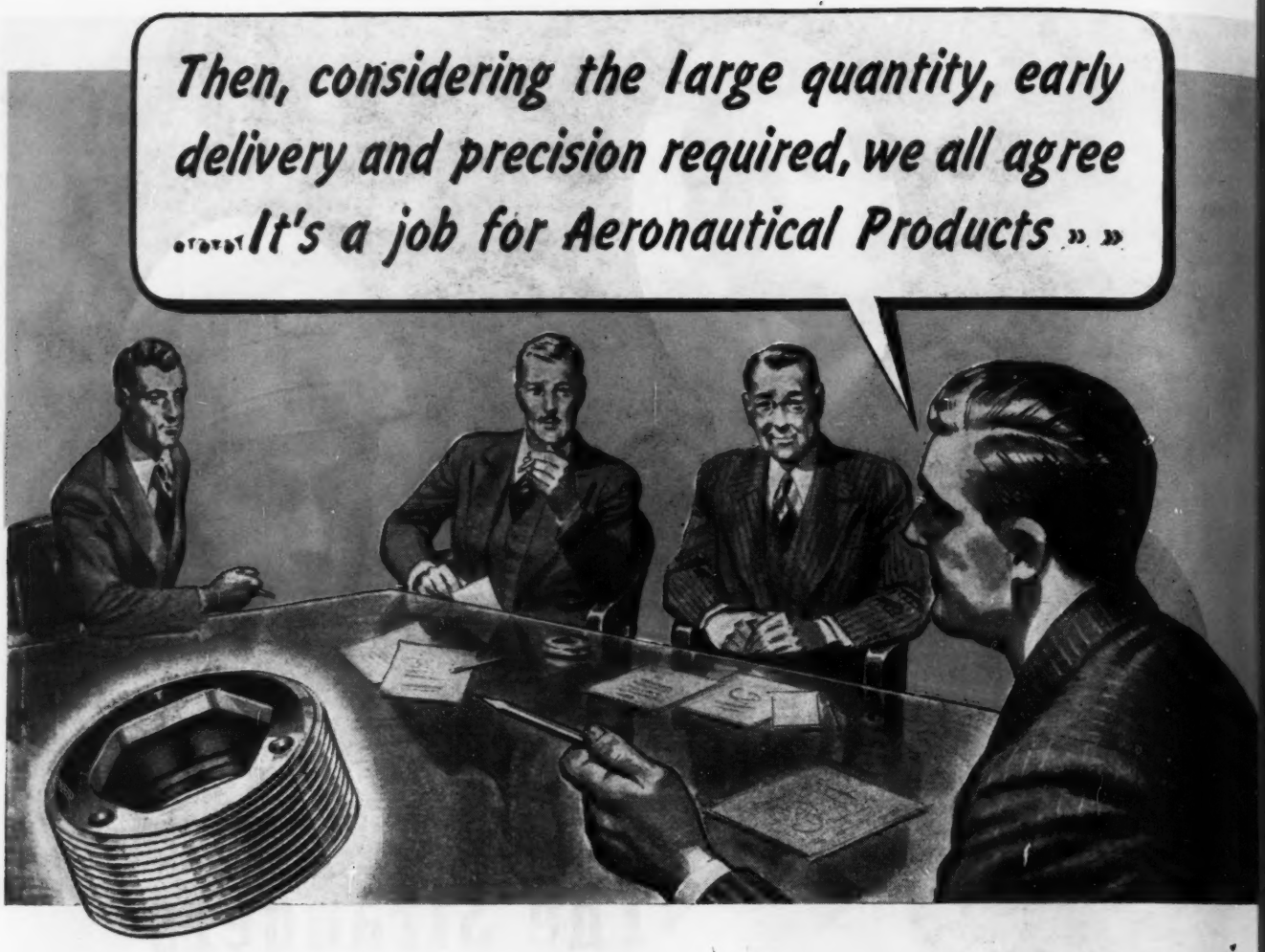
Already, we're dusting off the solemn aphorisms about not having died in vain, and we'll build a bright new marble cenotaph to his unknown father. But it isn't enough. Brother, it isn't enough!

We will emerge from this war the most powerful nation on earth. Our Navy and our Air Forces will be twice the size of all others combined — our manufacturing productivity will equal half the world's total capacity. If we can't enforce peace with that kind of club — and if we can't make jobs building houses for our sons to live in as well as by building tanks for them to die in — then God help us!

Today, the engineers of the basic machine tool producers stand ready to help the men of government and of industry to plan *now* for reconversion to a strong and prosperous America.

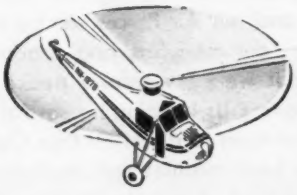
One of these is a Bryant man. We urge you to call him in today, for time is running out!

BRYANT CHUCKING GRINDER COMPANY SPRINGFIELD VERMONT, U.S.A.


Then, considering the large quantity, early delivery and precision required, we all agree ...It's a job for Aeronautical Products

WHERE ordinary thinking stops, Aeronautical Products' engineers begin. Where normal precision techniques leave off, Aeronautical Products' exceptional machining methods take over. It's only natural, then, that our mammoth capacity, engineering genius and creative skill developed long before the war and now devoted to total war output, will give us continued Leadership in the peacetime production of precision parts for every purpose. . . . Here in one organization with two great plants, is the *complete* precision parts picture . . . from creative engineering through all phases of manufacturing. So if you, too, are looking ahead, now would be a good time to solve your peacetime parts problem. Our Executive Sales Office will gladly mail you interesting facts on our plant facilities and equipment. Chances are, we have the answer you're searching for!

★ BUY WAR BONDS ★



● *Make ownership of a safe, sturdy Aeronautical Products Helicopter a "must" in your personal postwar plan. You'll find you can afford one!*

AERONAUTICAL PRODUCTS, Inc.

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and Administrative Offices:
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EASIER TO INSTALL

AN UNIVERSAL HOSE CLAMP

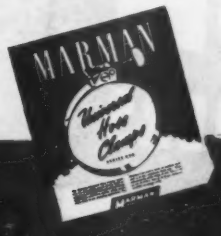
1. Retract screw fully. Wrap band around hose and insert end through opening in saddle.

2. Pull up snug, fold band down inside saddle, tighten screw.

TO TAKE OFF: Retract screw fully, press on screw, lift on free end of clamp.

Users of Marman Universal Hose Clamps report they are cutting installation time as much as 50%. Reason: tools or special adjustments are unnecessary with these flexible, high tensile stainless steel clamps. They're light and strong, can be used over and over without efficiency loss. No safety wiring required because of Marman's exclusive swivel-action nut. Non-slipping band conforms to hose contour, clamps irregular shapes with equal efficiency. Three sizes handle hose diameters from 5/8" to 3 5/8" O.D. (AN748-22 to -114 inclusive). Write today for new folder, Series 820.

Marman also makes other types of clamps, including the popular Quick-Coupler, in both stainless steel and aluminum alloy, in a complete range of sizes and shapes to fit any convex surface.



MARMAN PRODUCTS CO. Inc.

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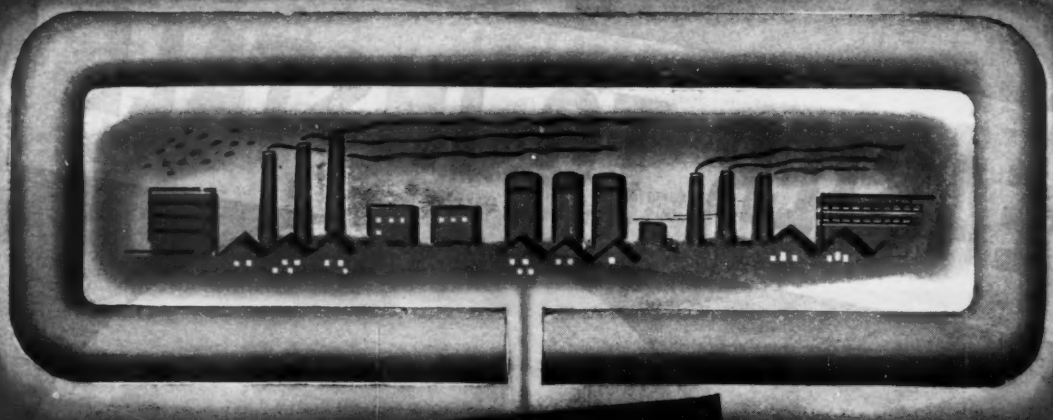


a Pre-view of Post-war Metal Stitching by Morrison

TIME savings of more than 70%, already achieved by Morrison Metal Stitching in many war industries, will be possible in a far broader field when peacetime production is resumed.

Postwar manufacture related to automotive, refrigeration, heating and ventilating equipment, prefabricated houses, washing machines, furniture, farm implements, luggage, aircraft or any product involving fastening problems, is in line for radical new economies through the Morrison method.

One outstanding example of the advances made in Morrison equipment is the Morrison Aircraft Metal Stitcher, a heavy duty machine tool. Previously this stitcher produced only a flat-type stitch, but new design now enables it to make a curved-type stitch as well. Furthermore, this double-efficiency machine is built to withstand the heaviest service, year in and year out, with a minimum upkeep cost.

Tests in America's leading aircraft laboratories have won approval of Morrison Industrial Stitching for all secondary and non-structural assemblies. Write for Folder A-55.

Above: Model SJH 25" throat Arm Stitcher. Below: Model SJS 25" throat Bottom Post Stitcher

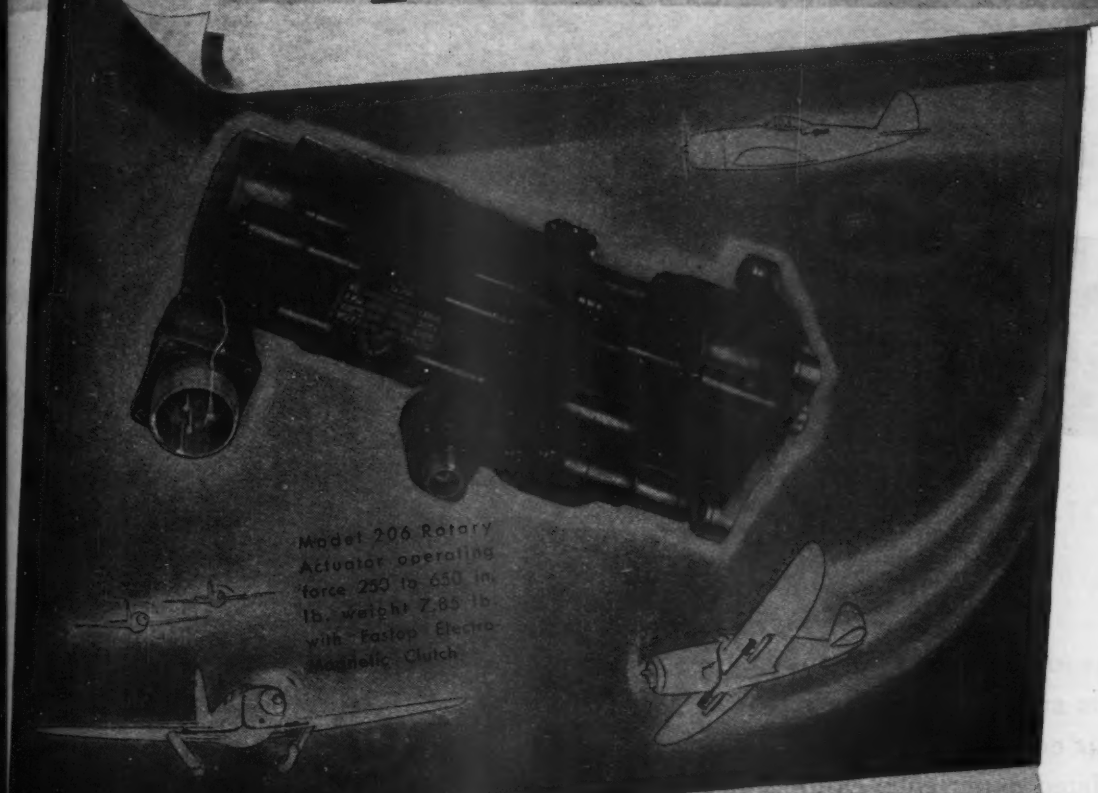
Also available: Models SJU (L.H.) and SJW (L.H.) 90° Angle Head Arm machines, producing a flat type stitch.

MORRISON STITCHERS

PRODUCTS OF THE SEYBOLD DIVISION
HARRIS-SEYBOLD-POTTER COMPANY
DAYTON F7, OHIO

We also manufacture a complete line of book, combiner, and steel stitchers

STRONG ARM SQUAD FOR PILOTS



At fighting aircraft speeds, pulling out of a dive calls for special hard-working flaps as well as a husky haul back on the stick. Even opening a canopy becomes a harder job than a pilot can manage.

Here you see the particular Lear Power Unit that handles these jobs on the famous Republic P-47 Thunderbolt. It was designed for these applications and also to actuate landing gears, landing-gear doors, wing flaps and gun-turret doors on other planes. Obviously it must be powerful, positive and reliable as well as light and strong.

And this is true of all Lear Actuators, Power Units, Controls and other aircraft equipment. They have all been tried and proved in all kinds of airplanes under the rigid requirements of war.

For any present or future planning, Lear engineers stand ready to contribute their experience with the use of such controls. They will be glad to help whenever a control or actuating problem arises.

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Gentlemen:
Please send me your free booklet showing Lear equipment and its many applications.

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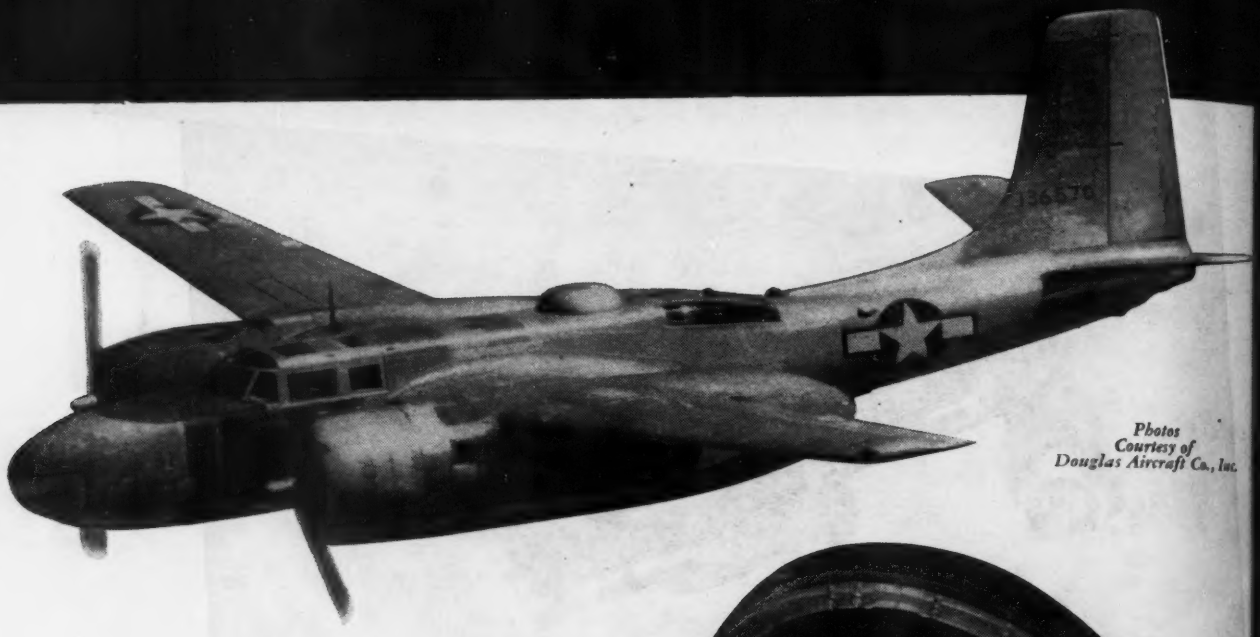
Marquette Aircraft Wipers



Photos Courtesy of Douglas Aircraft Co., Inc.

The A-26 Invader, its great all-round performance, its success, and the terror it carries to our enemies, is the result of all the accumulated experience Douglas has obtained from its many superb airplanes.

The Marquette Bombardier Wiper you see at the right is standard equipment on this plane. The successful installation of this wiper on the A-26 is the result of our considerable experience.

We have made over 170 different models of aircraft wipers since 1941. These have been in use all over the world,—under all kinds of conditions, and on many different airplanes.

ARMY E NAVY FOR EXCELLENCE

The Marquette METAL PRODUCTS CO.

CLEVELAND 10, OHIO

Manufacturers of: HYDRAULIC AND ELECTRIC WINDSHIELD WIPERS FOR AIRCRAFT
HYDRAULIC GOVERNORS FOR DIESEL ENGINES · ROLLER BEARING TEXTILE SPINDLES · FUEL OIL PUMPS
AIR COMPRESSORS · PRECISION PARTS AND ASSEMBLIES

Amphibious...

BOWER ROLLER BEARINGS!

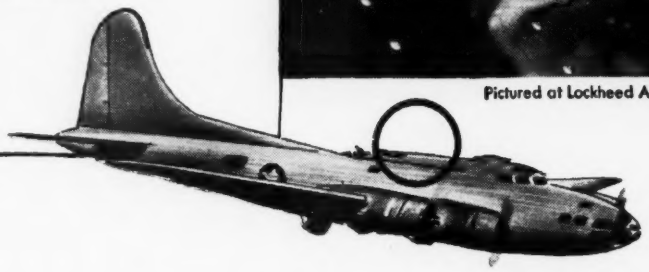
In world-famous American-made Amphibian Trucks, or "Ducks", so effective in landing operations, Bower Roller Bearings carry the rolling load. All over the globe Bower Roller Bearings are serving in the great war machine of the Allied Nations.

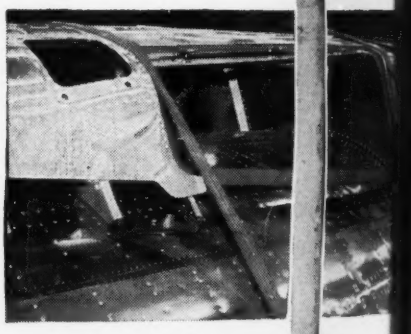
BOWER
ROLLER BEARING CO.
Detroit 14 Michigan

Here's the right blind rivet for your TOUGH AIRFRAME JOBS

Using Cherry Blind Rivets to install the hinge on a safety-raft emergency door . . . this is a true blind spot, riveted quickly and easily from one side by one workman.

Pictured at Lockheed Aircraft Corporation, Burbank, California.





Same fuselage location as top of page, showing blind characteristics of application prior to installation of fairing and hinged door.

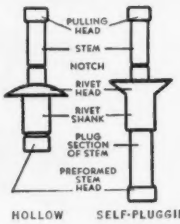
Cherry Blind Rivets do make easy riveting—simplify difficult airframe jobs—offer you outstanding advantages over other fasteners. They are the right rivets for your tough jobs . . . and here are a few of the reasons why . . .

The patented stem pulling head makes gun engagement easier—allows use of small, easy-to-handle guns—makes it easier to get at tough spots.

The enlarged plug section in the stem forces maximum shank expansion—enough to meet all normal manufacture and repair conditions without size-drilling or reaming.

Generous grip length tolerances allow variations to .064".

These are only a few reasons why Cherry Rivets are right for your tough jobs. Why not let us tell you more?



For further data on Cherry Blind Rivets and guns, and the many jobs they can do for you, address Department A-110 for Manual D-45 and metal demonstration panel. Cherry Rivet Co., 231 Winston Street, Los Angeles 13, Calif.

CHERRY RIVETS, THEIR MANUFACTURE & APPLICATION ARE COVERED BY U. S. PATENTS ISSUED & PENDING

Cherry Rivet *Company*

LOS ANGELES, CALIFORNIA

Tubing. Raw stock from ¼" to 2" diameter in a variety of metals is shaped into finished parts ranging from a few inches to 4½ feet in length.

Former Ring and Flap Assembly. Rohr manufactures 120 major parts for this assembly and there are 14 major assembly operations.

Nose Ring. We make 121 major parts used in this assembly and perform 22 major assembly operations.

Miscellaneous Parts. Dozens of different types of metals are worked into intricate sizes and shapes to create these parts.

Duct Assemblies. The principal assemblies require manufacture of 285 parts and 58 major assembly operations.

Preheater. 82 major parts are manufactured here for preheaters and 12 major assembly operations are required.

Electrical Assembly. There are 445 major parts used for this assembly and 14 major assembly operations are required.

over 5000 manufacturing, assembling and inspecting operations get these power plants ready to fly!

ROHR AIRCRAFT CORPORATION

COMPLETE POWER PLANT ASSEMBLIES FOR MILITARY AND CIVILIAN AIRCRAFT

ROHR AIRCRAFT CORPORATION, CHULA VISTA, CALIFORNIA • *Helping to write the story of tomorrow*

There's a correct S/V Sova-Kote to meet your specific requirements. Stop Rust Before It Starts!

LIKE a thief in the night, rust attacks the products of your plant. It's an ever-present threat to unfinished parts between operations. It goes to work on finished parts in transit and in storage.

The best way to guard against this threat is to make sure that you have a proved rust preventive suited to your particular needs.

No matter what your requirements may be—indoor or outdoor protection, simple or intricate parts, light or heavy-duty service, hot or cold application — you'll find the correct answer in the complete S/V Sova-Kote line. For this line includes outstanding products developed to solve all current rust prevention problems.

On your request, your Socony-Vacuum Representative will study your special needs and help you select and apply the best possible rust protection. Why not get his expert advice and stop rust on your products before it starts?

SOCONY-VACUUM OIL CO., INC.
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SOCONY-VACUUM'S 5 Steps to Lower Production Costs:

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2. Lubrication Schedules and Controls
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A Place in the Sky . . .

Berryloid Aircraft Finishes

For nearly a third of a century Berryloid has been the standard in aircraft finishes. Through two wars Berryloid research and development have blazed new trails in perfecting better, tougher, more weather-resisting finishing materials. This pioneering has resulted in advancements that have made the Berryloid mark of quality known and appreciated all over the world.

The fact that Berryloid is the most widely known and used line of aircraft finishes, in war and peace, is a tribute to a record of outstanding achievement . . . to Berryloid's place in the sky. Battle-tested, weather-tested, Berryloid finishes will add color, longer life and greater durability to helicopters, jet-propelled aircraft and commercial and private planes of the future.

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AIRCRAFT FINISHES

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Paints · Varnishes · Enamels · Lacquers
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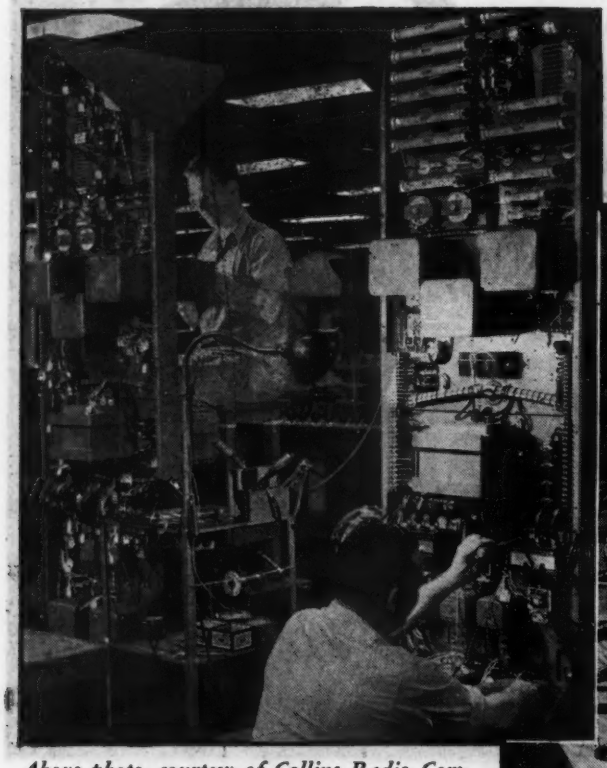
It's Just A Case of Making the Right Connection

--WHITAKER CUSTOM-MADE CABLE ASSEMBLIES *are supplied ready to install*



Above photo, courtesy of Collins Radio Company, Cedar Rapids, Iowa. It shows installation of a Whitaker Assembly in a Collins TDO Transmitter . . . Illustration at right shows Assembly being made at Whitaker plant.

IF YOUR PRODUCT requires

★ WIRING HARNESSES ★ CABLE ASSEMBLIES

★ BONDING JUMPERS ★ CABLE or TERMINALS

- - you'll find WHITAKER a dependable source

You can *save time and money* by having Whitaker produce the cable assemblies required for *your* products . . . In turning your wiring jobs over to us, you are making the right connection for *quality* merchandise made to exacting specifications, and when your men install the completed assemblies, they will find every lead and terminal properly positioned for the right connection . . . You win both ways . . . Furthermore, you will find your production costs reduced as the result of utilizing our specialized facilities. You get full benefits of our 25 years of experience, our ample production facilities, skilled manpower, and the economies resulting from our use of modern methods and special equipment.

Whitaker Can Wire It

In addition to an engineered wiring service, Whitaker also offers a quality line of standard cable products.

Write for latest catalog, and complete information.

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General Offices: 1301 Burlington Avenue, Kansas City 16, Missouri

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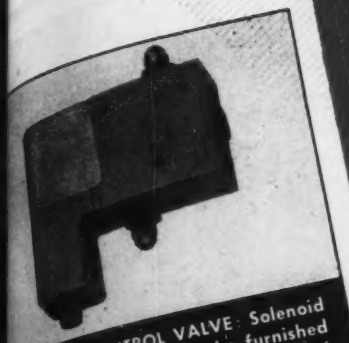
Interstate

has long specialized in the pioneer-engineering of valves. In many instances these valves have been far ahead of the field in meeting specific problems of design and actuating performance. Thus, in a small but important way, Interstate Valves are helping to speed Victory — by increasing the efficiency of the planes they serve.

Have you a valve-problem? Put it up to men who know! Write Sales Dept., Interstate Aircraft and Engineering Corporation, El Segundo, Calif.



TWO PORT CONTROL VALVE: Solenoid operated 18-28 volts; can be furnished normally closed or normally open. 6 G.P.M. flow. Current drain .3 (3/10) Amp. For use on pressures up to and including 3000 p.s.i.

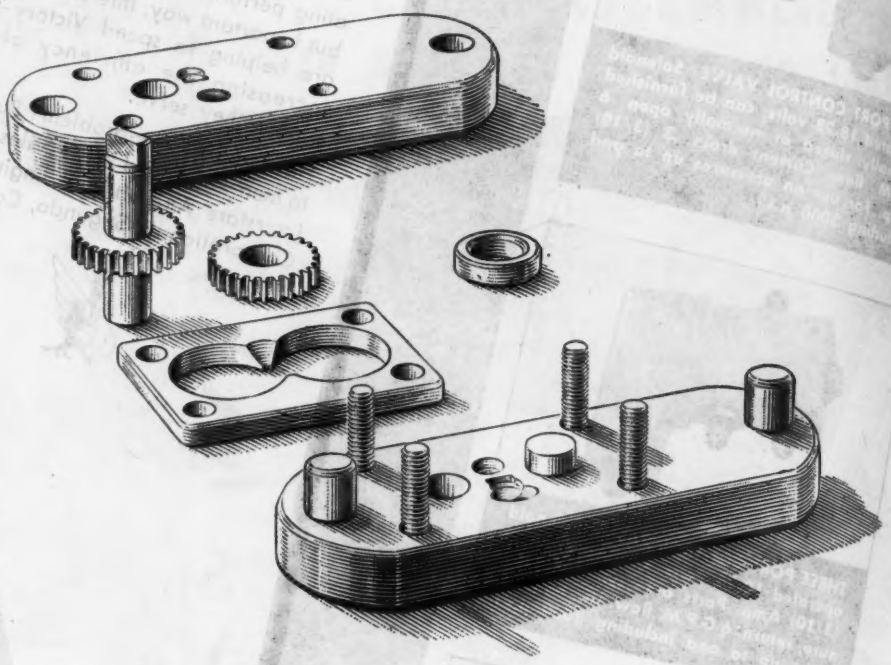
THREE PORT CONTROL VALVE: Solenoid operated 18-28 volts. Current drain .3 (3/10) Amp. Ports are: cylinder, pressure, return. 6 G.P.M. flow. Use on pressures up to and including 3000 p.s.i.

FOUR PORT SELECTOR VALVE: Solenoid operated 18-28 volts. Current drain .160 (16/100) Amp. Ports are: cylinder 1, cylinder 2, pressure and return. 6 G.P.M. flow. For use on pressures up to and including 3000 p.s.i.

THREE WAY CONTROL VALVE: Manually operated. Ports are: cylinder, pressure, return. Has synthetic poppet for use with gas or fluid. Pressures up to 1500 p.s.i.

VALVES TOO, ARE IMPORTANT IN WINNING VICTORY

Accurate



TO ±.000025" WITHOUT PRE-SELECTION OF PARTS

Accustomed to thinking of tolerances in "tenths"?

Then you can readily appreciate the problems overcome in mass-producing this gear-driven metering pump, where vital dimensions must be held, not just to ten-thousandths of an inch, but to "quarter tenths"!

Consider these "musts": undeviating accuracy of the gear teeth...precise thickness and concentricity of the gears themselves...uniform gear-chamber clearances...four holes in the side plates located, ground and exactly spaced on a perfectly straight center line...lapping to ±.000025". Add to this, *strict interchangeability of parts.*

Do you wonder that leading engineers frowned on its practicability in mass-production...had discarded the principle of the geared pump with an "it can't be done"?

But W. H. Nichols and Sons is doing it. Engineering its production so that strict interchangeability is possible *without pre-selection of any of its parts*, Nichols has produced over 400,000 of these pumps and is still at it. Called "the most accurate assembly of commercial parts ever produced," this pump is essential equipment today in 95% of our rayon plants.

You may never need a rayon pump. *What you may need is the ability that made it.* The same Nichols engineering skill, mass-precision methods and production facilities that went into the successful development of the Rayon Pump can be your answer to an equally difficult manufacturing problem.

Perhaps *you* have shelved a good idea that "couldn't be done right." Then it's the job to discuss with "Accurate" Nichols.

W. H. NICHOLS & SONS, WALTHAM 54, MASS.

"Accurate" *Nichols*

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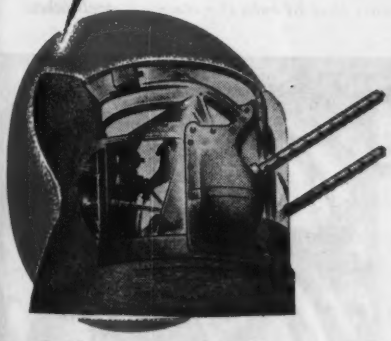
PRECISION ENGINEERING AND MANUFACTURING FACILITIES FOR MASS PRODUCTION

Specimen Dimensional Drawings and Connector Charts of Emerson-Electric Aircraft Motors

Quickly find...

Detailed Specificational Data on 405 AIRCRAFT MOTORS



For quickly finding detailed specifications on 405 Aircraft Motors, turn the pages of this Emerson-Electric Aircraft Motor Engineering Data book.... If you haven't a copy, send for it immediately. It lists Aircraft Motors with ratings from 1/200th to 6 H. P.—Full-load standard speeds from 1750 to 7500 r. p. m.—Weights from 17 oz. to 23 lb.—Full-load amperes from 0.9 to 290—Reversible or unidirectional rotation—PLUS numerous modifications of speeds, mountings, drives, and couplings.

To help you with any special Aircraft Motor application problem, a competent sales engineer from your nearest Emerson-Electric sales office is available for consultation.

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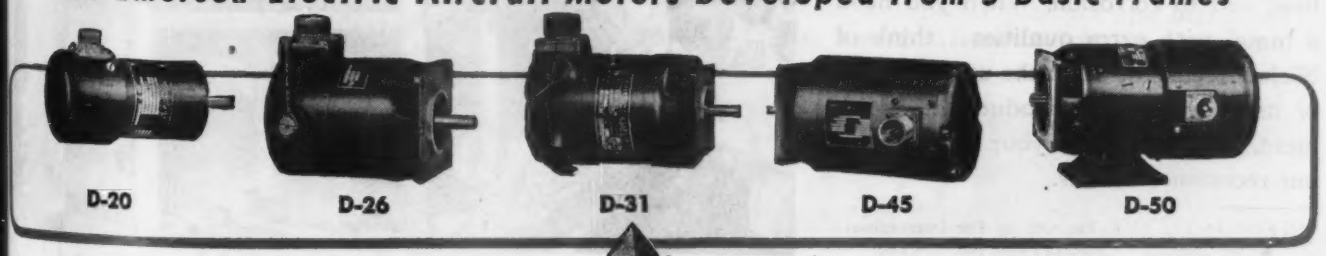
405 Emerson-Electric Aircraft Motors Developed from 5 Basic Frames



EMERSON ELECTRIC
MOTORS · FANS — APPLIANCES

Major Improvement

IN EXHAUST MANIFOLDS

THROUGH NEW PARTS OF

NI-RESIST*

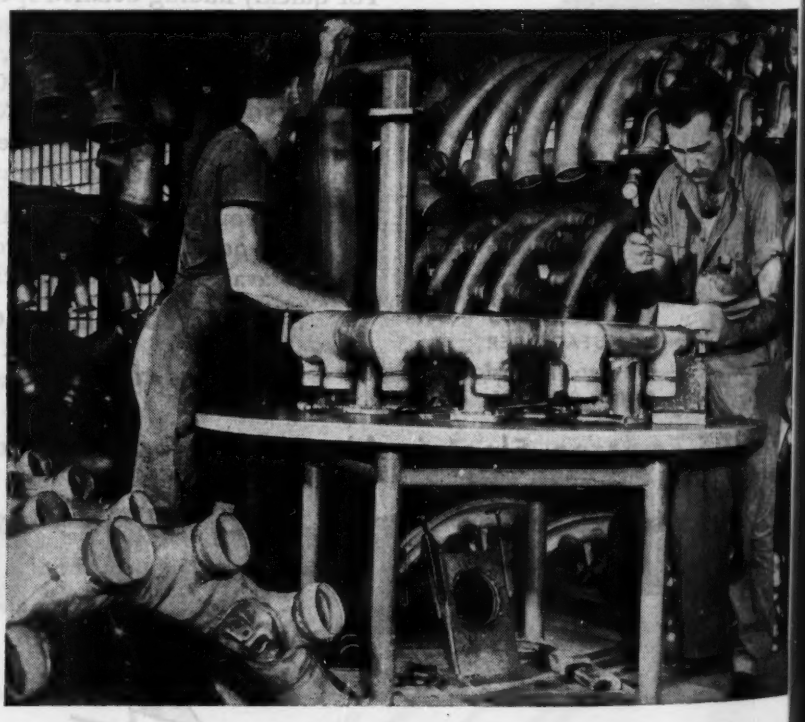
● *Originally, plain cast iron ball joints fitted with sealing rings were used in the universals but they required frequent replacement due to growth and corrosion from exhaust gases which attain temperatures of 1500° to 1800°F. and dimensional changes that allowed leakage. Now . . . sealing rings are eliminated. Leakage is prevented by machining closely spaced annular grooves on the outer surfaces of the Ni-Resist ball joints that fit into the stainless steel sockets.*

An improved exhaust manifold assembly containing flexible joints developed by Ryan Aeronautical Company prevents the transmission of engine vibrations through the manifold to the air frame. A collector ring receives the exhaust from the cylinders through stainless steel connecting tubes having "ball and socket" joints employing Ni-Resist balls. These flexible joints permit mounting the manifold onto the air frame.

Ni-Resist balls fitted into stainless steel sockets provide for the flexibility and free movement of the parts of the joint assembly and prevent leakage of the heated exhaust gases.

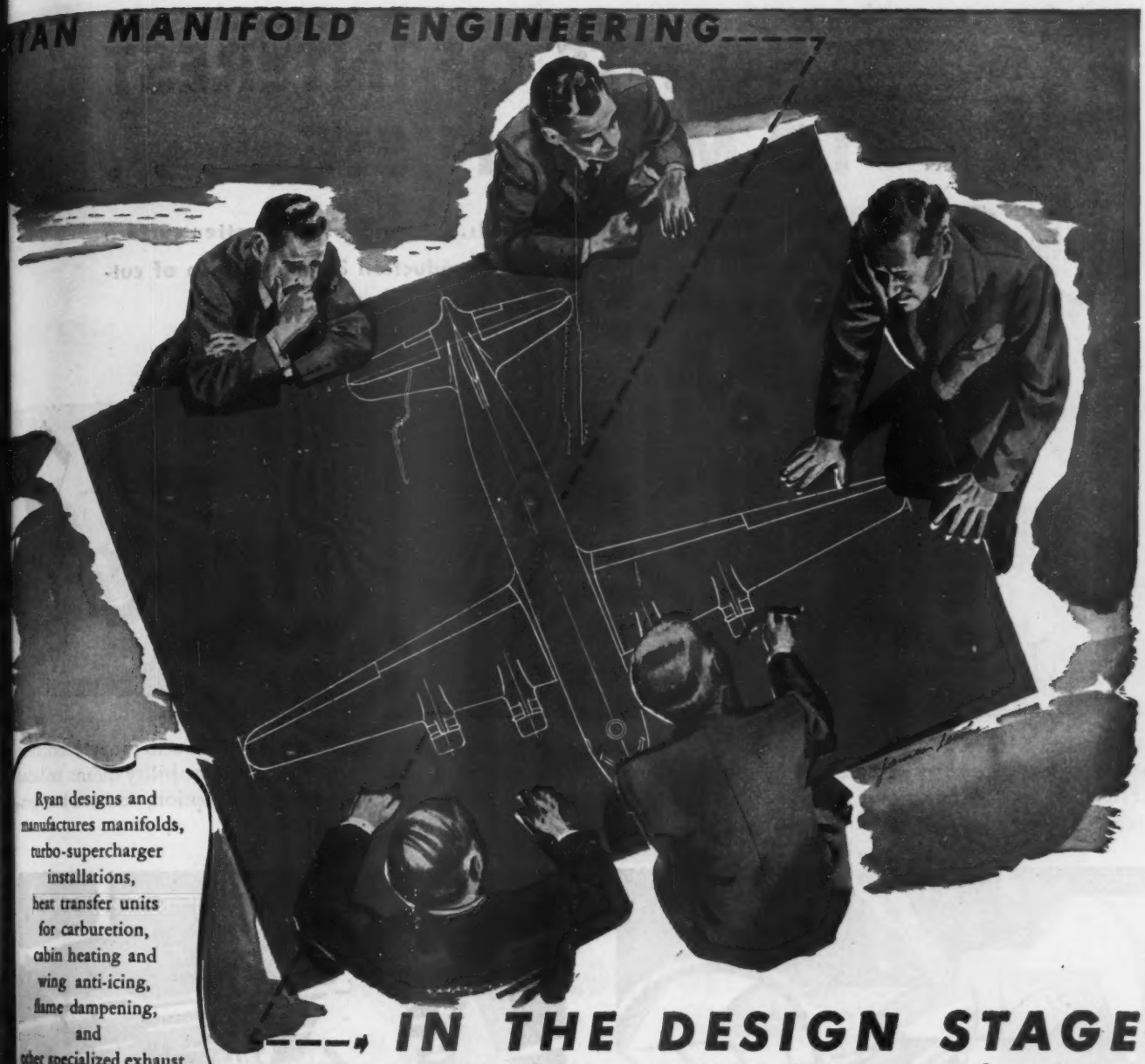
The alloyed balls adopted by Ryan several years ago and since employed in large quantities, have spectacularly demonstrated the ability to provide satisfactory resistance to wear, growth, galling and other thermal and mechanical influences involved in this application.

Both stainless steel and Ni-Resist are fortified with Nickel. Nickel imparts strength, toughness, hardness and resistance to heat and to corrosion. When you need a metal with *extra* qualities . . . think of Nickel . . . consult us on the use of Nickel or its alloys in your products or equipment. Send details of your problem for our recommendations.



*NI-RESIST — Reg. U. S. Pat. Off. by The International Nickel Company — Canadian Patent No. 278,180

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N.Y.



Ryan designs and manufactures manifolds, turbo-supercharger installations, heat transfer units for carburetion, cabin heating and wing anti-icing, flame dampening, and other specialized exhaust system applications.

——, IN THE DESIGN STAGE

means lower weight, better performance

To plan the exhaust manifold system when the original design for the airplane is being made saves costly engineering time, brings reduction in weight, and results in better performance. In a typical instance a Ryan manifold design saved forty-eight pounds in the weight of a military transport plane.

By planning with Ryan during the design stage, the type of manifold system and installation best suited to your specific requirements can be readily ascertained.

Whether planning to use Ryan ball and socket type or slip-joint type manifolds, let Ryan work with you in the *design* stage. You will obtain a superior product and maximum performance, and, in wartime, *lower weight;* in peacetime, *bigger payload.*

RYAN

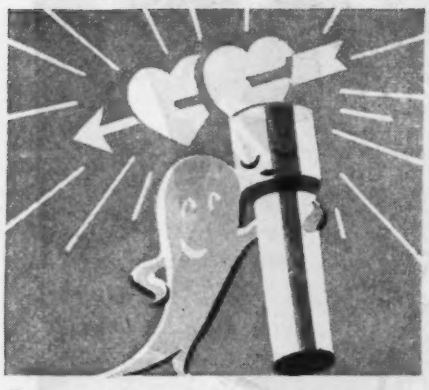
RELY ON RYAN TO BUILD WELL 1922-1945

Ryan Aeronautical Company, San Diego — Member, Aircraft War Production Council, Inc.

DESIGNERS AND BUILDERS OF NAVY FIGHTING PLANES AND EXHAUST MANIFOLD SYSTEMS

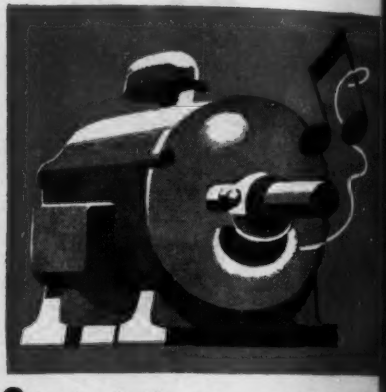
SOME POINTS OF INTEREST TO MACHINISTS . . . .

You can get faster cutting speeds, longer tool life, better surface finishes and generally increased production if your choice of cutting oils is made with these thoughts in mind . . . .



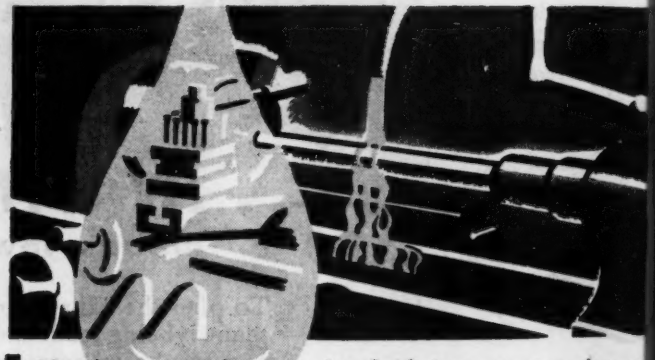
1 Be sure you select a cutting fluid which keeps the tool cool and which possesses the right chemical affinity for the metals you are working.

2 Proper cooling is important because the fluid then helps prevent the thermal distortion which causes uneven surfaces and inaccurate final dimensions.



3 Buying fluids with proper lubricating qualities and stability means reduced power consumption, wear and heat generation.

4 The right cutting fluid helps provide satisfactory chip formation and washes away the chips, (particularly desirable in hack sawing, milling, grinding and deep hole drilling).



5 Also, be sure you buy a cutting fluid that protects against corrosion of workpiece and machine and that lubricates moving parts close to the cutting tool.

The final point to remember is to buy Red Line Cutting Fluids. For Red Line Cutting Fluids give you all these qualities. That's because each fluid is from a carefully developed formula based upon extensive research and practical experience in the machinery industry. So for safer, better production, join the hundreds of shops that use Red Line Cutting Fluids. To get a supply, simply phone your local Union Oil representative or write Union Oil Company, 617 West 7th Street, Los Angeles 14, California.

RED LINE CUTTING FLUIDS

UNION 76

Another UNION OIL *Success-Tested Product*

Design for a Machine Tool Control by PARKER

Consider this as an example of the many types of machine tools that are designed to use tubing systems for hydraulic control and for lubrication.

When a machine tool tubing installation is designed in conformance with sound Fluid Power Engineering principles it will:

(1) Allow the closest practicable approach to perfect streamline flow which in turn will reduce to a minimum the capacity and pressure requirements on the power source and give a better response to control throughout the entire system.

(2) Permit the efficient use of available space . . . no matter how cramped this space may be . . . and still provide a system that allows unobstructed service and maintenance on all component units of the system.

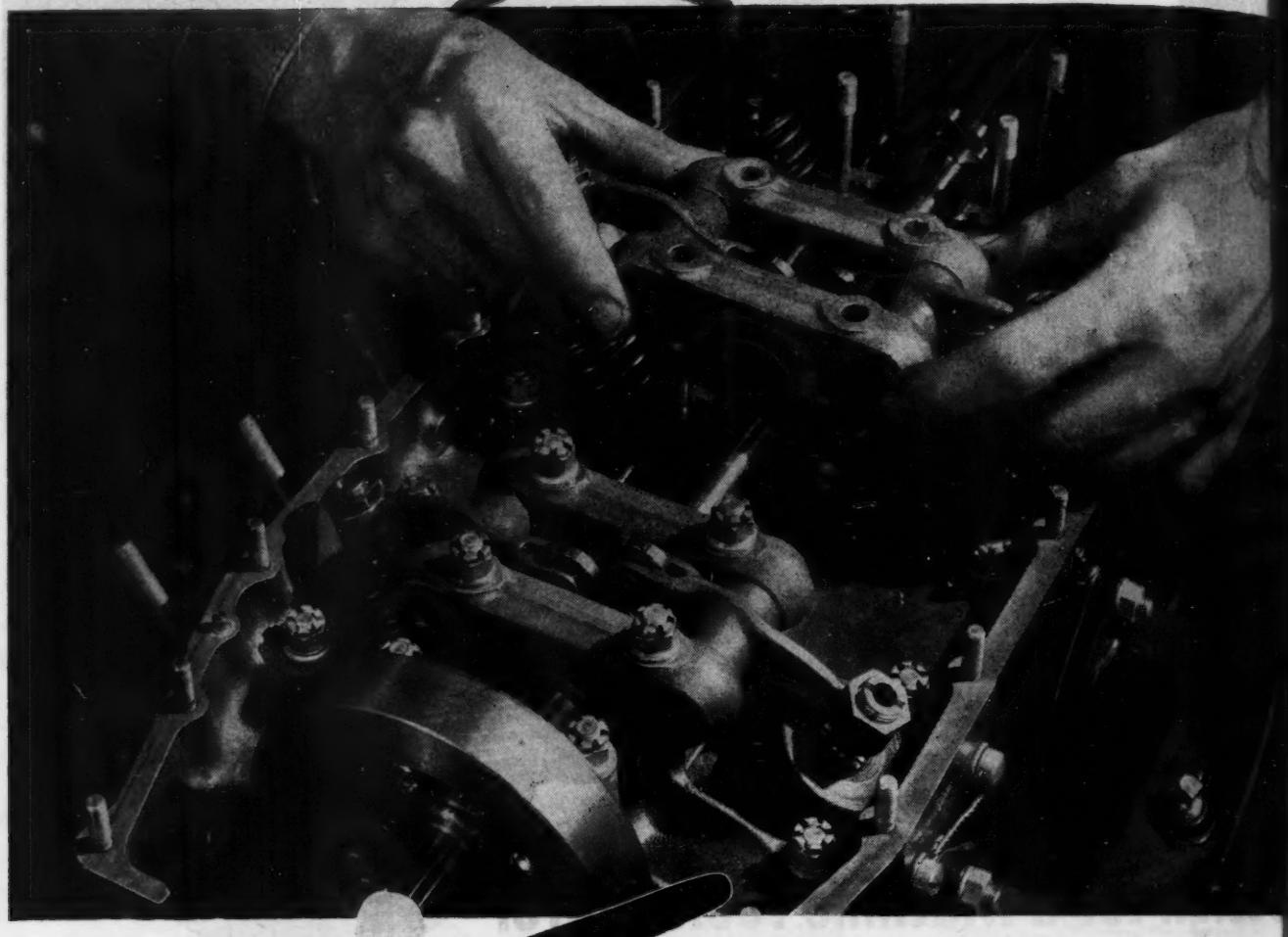
(3) Reduce the number of joints and connections to a minimum . . . each one tight, leakproof and able to withstand excessive abuse, vibration and pressure.

Parker valves, fittings and fabricated tubing—plus Parker Engineering—will give you a simple, neat installation, easy to service, free from troubles, efficient and economical.

Whatever you make—motor vehicles, earth-movers, presses, aircraft, refrigeration or process equipment, ask a Parker engineer for recommendations based on this "know-how". Write to The Parker Appliance Company, 17325 Euclid Avenue, Cleveland 12, Ohio. Booklet on request.

THE PARKER APPLIANCE COMPANY
CLEVELAND 12, OHIO
FLUID POWER ENGINEERING

A Good Engine ~~Deserves~~ *must have* GOOD FASTENERS



Camshaft and valve assembly in Ranger aircraft engine, using National Fasteners. Left, Fairchild AT-21 "Gunner" powered by two Ranger 12-cylinder inverted, air-cooled engines.

Our specialty is Aircraft Fasteners.

We make other fasteners, too, but we have been particularly successful in meeting the requirements of the Air Forces.

That applies to both standard and special fasteners. It is true as to quantity and quality. *The Air Technical Service Command has designated this company as a "Quality Control Approved Facility".*

Our new 176-page catalog of Aviation Products is tangible evidence of National's contribution to aircraft manufacture. If you can use this "encyclopedia of aircraft fasteners", please write for a copy on your company letterhead.

National
HEADED AND THREADED
PRODUCTS

THE NATIONAL SCREW & MFG. CO., CLEVELAND 4, O.

OLSEN 120,000 LB. UNIVERSAL WITH HIGH MAGNIFICATION RECORDER IN DAILY USE BY LARGE AIRCRAFT ENGINE PLANT

The physical characteristics of a material are never so clearly seen as when magnified and recorded on a stress-strain diagram. New values are set forth which are vital in order that service conditions and proper safety factors may be met. An Olsen Universal Testing Machine with High Magnification Recorder puts the following information at your finger tips:

1. Modulus of Elasticity
2. Hysteresis
3. Elastic Deformation
4. Proportional Limit
5. Yield Strength (Yield Point)
6. Proof Stress (Proof Strength)
7. An aid in fatigue problems
8. An aid in cold working problems.

Olsen Universals with High Magnification Recorders are doing two vital jobs for industry today:

1. Making materials acceptance and inspection a routine production operation.

2. Putting on one chart sheet the stress strain diagram of any material so that all basic characteristics are clearly seen in their relative lights.

TINIUS OLSEN TESTING MACHINE CO.

560 N. TWELFTH ST. PHILADELPHIA, PA.

Western Representative: **PACIFIC SCIENTIFIC COMPANY**

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Proving Every Day that the Value of Testing Depends on the Quality of the Testing Equipment.

GIANT SHEETS
highly polished!

. . . another
EASTERN STAINLESS feature!

Eastern Stainless craftsmen are all specialists in Stainless who take particular pride in their ability to furnish very large sheets finished precisely to your specifications.

If your requirements demand a brilliantly polished, mirror-like surface — one or both sides — you'll want the Eastern Stainless No. 7 Finish, one huge sheet of which is illustrated here. Or perhaps you require a somewhat less reflective sheet possessing a "satin" appearance. If so, you'll choose the Eastern Stainless No. 4 Finish. Then again, the job at hand may call for another of the seven popular sheet mill finishes Eastern Stainless offers to meet every need.

Come to Eastern for the answer whenever Stainless is the question. Eastern Stainless furnishes twelve standard and several special grades, all of highest quality, in a wide range of sizes and finishes. Consult the Eastern Stainless Technical Staff . . . you'll receive prompt, helpful service.

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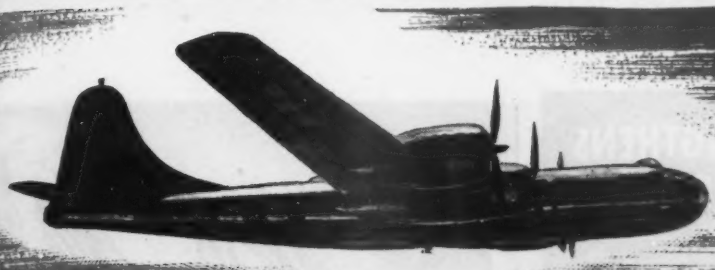
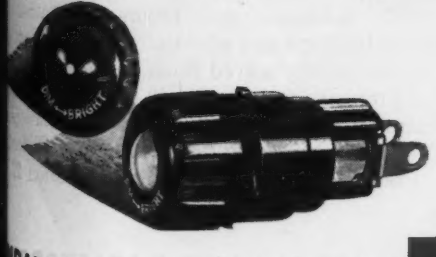


Standair LIGHTING EQUIPMENT

Rides War Skies with Majestic BOEING B-29

NDAIR C-4A Cockpit Lamp Assembly.
cification 94-32294-C; S.A. 4297-D.
1 oz., overall length 5⅝", diam. 1¾".



NDAIR Warning Light Assembly.
. Dwg. No. 4283593; S.A. 3821-B.
oz., overall length 2¼", diam. ⅞".

In every theater of war throughout the world, sturdily constructed STANDAIR Lamps and Lights are doing their part as essential equipment.

The new STANDAIR C-4A Cockpit Lamp Assembly, with chain lock filter and retractable cord, is used as an auxiliary light source on all types of aircraft. Both the C-4A and its companion product, the STANDAIR Warning Light are made to meet the latest U. S. Army Air Forces specifications.

The STANDAIR Warning Light assembly is sealed for complete confinement of light, and is equipped with an opening and closing ring curtain. This light simplifies checking landing gear, oxygen, prop limit, bomb release indicator and many other operations on modern fighting aircraft. It is 90% plastic, so a large number of lights can be used without materially affecting the weight of the plane. For additional information on these and other products in the STANDAIR line, write us at Dayton, or address our sales office nearest you.

Standard Aircraft Products Inc.
DAYTON 2, OHIO

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KEEP ON BUYING WAR BONDS

ALUMINUM BRAZING LENGTHENS LIFE OF HEAT EXCHANGERS

Designers of heat transfer units are now achieving increased strength . . . not only *without* added structural reinforcements but also *with* a ⅔ weight reduction . . . by replacing copper and soft solder with aluminum and high temperature aluminum alloy bonding material.

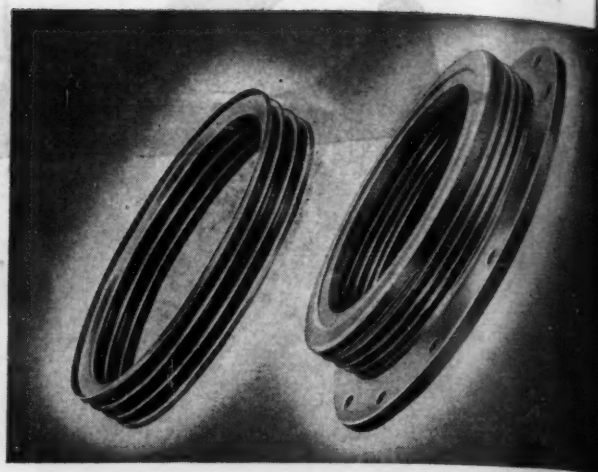
Clifford's notable discovery of the method of brazing aluminum in thin sections has resulted in the strengthening of heat transfer units three ways:

1. Heat treatable aluminum tubes resist working temperatures up to 275°, at which point copper tubes gradually anneal and break down.
2. Heat treatable aluminum alloy header plates, shells and other parts survive temperatures and pressures far above the safe limits of other metals commonly used in heat transfer units.
3. High temperature aluminum alloy bonding material withstands temperatures, pressures and strains several times higher than soft solder.

Those are the plusses USAAF designers obtained for several types of aircraft when Clifford Feather-Weight Oil Coolers and Coolant Radiators saved ⅔ the weight of the copper units they replaced.

ALUMINUM BRAZING'S FUTURE

Clifford's production is still 100% in war work. However, postwar applications of all-aluminum heat transfer units to automotive, heating, cooling and ventilating fields are being considered on the basis of suggestions and inquiries already received. Yours will be welcomed. *Clifford Feather-Weights save ⅔ the weight . . . same size and shape.* Clifford Manufacturing Co., 561 E. First Street, Boston 27, Massachusetts.



HOW HYDRAULICALLY-FORMED BELLOWS IMPROVE SHAFT SEAL PERFORMANCE

Shaft seals must be engineered to each application becau conditions are seldom the same: the nature of the gas liquid to be sealed; the pressure which the seal must oppo the shaft diameter; its speed in r.p.m.; the space the seal w occupy; working temperatures.

Also in the design of such seals, problems like these mu be solved:

The *seal nose* must be properly proportioned to preve distortion during facing and during exposure to high servi temperatures.

The *bearing material* must be scientifically correct for t specific operating conditions.

The *thrust spring* must exert proper thrust at its worki length — parallel to the axis.

And even when these components are *right*, the seal w not provide a pressure-tight running seal against the rotati shaft shoulder *unless* the bellows has *sufficient strength* stand the pressures involved and has the required flexibili

That's where hydraulically-formed metallic bellows sea are superior to non-metallic and other metallic seals. Cli ford — first to produce hydraulically-formed metallic bello for industry — incorporates in shafts seals Hydron bello with uniform wall thickness and accurately controll metallurgical grain structure and physical properties. That why Clifford has successfully solved some of America's mo difficult shaft seal problems and why it will pay you to subm your seal problems to them for their recommendation *First with the Facts on Hydraulically-Formed Bellows.* Clifor Manufacturing Company, 561 E. First Street, Boston 2 Massachusetts.

CLIFFORD *Feather Weights* **OIL COOLERS AND COOLANT RADIATORS**

HYDRAULICALLY-FORMED BELLOWS HYDRON

FOUR FREEDOMS IN FLIGHT...

THE SPERRY ATTITUDE GYRO OFFERS FREEDOM FROM
CAGING · TUMBLING · MISINTERPRETATION · FATIGUE

Now, for the first time, the pilot knows the attitude of his plane continuously, at any flight angle, regardless of visibility or extreme turbulence.

An electrically driven gyro stabilizes a sphere which is universally mounted—without limit stops—allowing full 360 degrees freedom of indication about the roll and pitch axes of the airplane. (The airplane actually maneuvers around the indicating sphere.) No caging is needed!

Pattern indication by daylight or by artificial light gives the pilot a quick, visual picture of his attitude at all times—a single glance tells the story. Thus the pilot can control his aircraft under instrument conditions for long periods without fatigue.

The Sperry Attitude Gyro makes instrument flying safer, easier, and more versatile. Write our Aeronautical Department for further information.

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This Highly Mechanized Bronze Foundry is turning out *Extra Miles* for planes-trains-ships

Because of this department—aircraft engines have longer efficient life—overworked, overloaded locomotives have increased availability—marine auxiliaries deliver several times the service.

WHY

Because this highly mechanized foundry, with all modern equipment from molding machines to induction furnaces, permits *quantity* production on a *quality* basis. The better bronze castings produced mean longer-lasting aircraft sealing rings for aircraft engines . . . longer-lasting main cylinder packing for locomotives . . . longer-lasting bronze-iron rings for marine auxiliaries.

The new things learned, the new facilities added, and the new methods developed all mean that this organization will be better than ever equipped to give you better peacetime Piston Rings In Every Size —Of Every Type—For Every Purpose.

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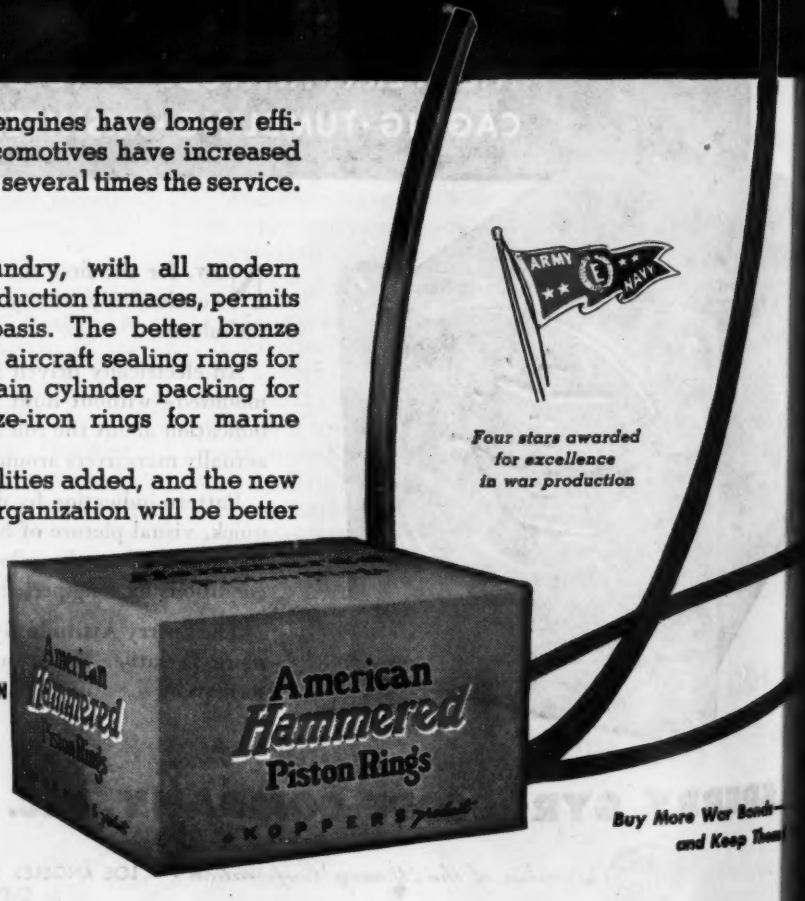
AMERICAN HAMMERED PISTON RING DIVISION
Baltimore 3, Maryland

KOPPERS
THE INDUSTRY THAT SERVES ALL INDUSTRY



Four stars awarded for excellence in war production

Buy More War Bonds— and Keep Them

FOR TOMORROW — count on those who are doing the tough job

TOUGH SAWING MADE EASY

DoALL Buttress

THE NEW WIDE-SPACED HARD TOOTH SAW

ALUMINUM
MAGNESIUM
and all
NON-FERROUS
METALS

PLASTICS

RUBBER

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This sensational saw is making history in war plants today and when civilian goods are again in production, many of the new materials will be used and cut with this same saw—the DoALL Buttress, which fits any band sawing machine.

Its special construction — with wider spaced, extra hard teeth — means ample chip clearance, no clogging, longer saw life. The sum total is quicker, smoother straight-line and contour cutting.

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The Buttress holds its edge until it's worn out — without re-sharpening. It is then replaced with a brand new band. This means no lost time, no work stoppages.

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Various widths and pitches — a proper one for each job. Available at all our supply points.

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Saves industry thousands of dollars every month. If you have trouble cutting some material because of hardness, sponginess, brittleness, etc., send us sample. Our research engineers will make dozens of tests until they find the proper saw and speed.

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Write for literature about the surprising performance of the DoALL Buttress

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EVEN ENGINEERS ARE FROM MISSOURI . . . *Until they Fly behind it!*

This Variable Pitch "Propeller with a Brain" Works Wonders in Performance . . . Automatically

YES, we can give engineers technical data from which they can figure, with mathematical precision, exactly how and why the Aeromatic Propeller works. *But it still seems too good to be true . . . until they fly behind it!* Then they get the feel of what they've figured and . . . YEAH MAN!

In terms of performance for your postwar plane, Aeromatic means one-fourth shorter takeoff runs . . . one-third higher rate of climb . . . cruising faster and farther at the most favorable altitude . . . all with minimum fuel consumption and engine wear. And it means long glides for happy landings . . . with an instantaneous change of pitch for a quick pickup if you overshoot the field.

What's more, it's important to remember that the Aeromatic Propeller requires no instruments . . . no controls . . . nothing extra for you to watch or do. It's the one and only propeller that lets your plane and engine deliver . . . automatically . . . *all* the performance that is built into them.

If you fly, or plan to fly, you'll want an Aeromatic Propeller on your plane. Write to your aircraft manufacturer about it today. And if you'd like our little get-acquainted folder, containing a diagram of the "brain" in an Aeromatic Propeller, don't hesitate to write to Aeromatic, 246 Scott Street, Baltimore 3, Maryland.

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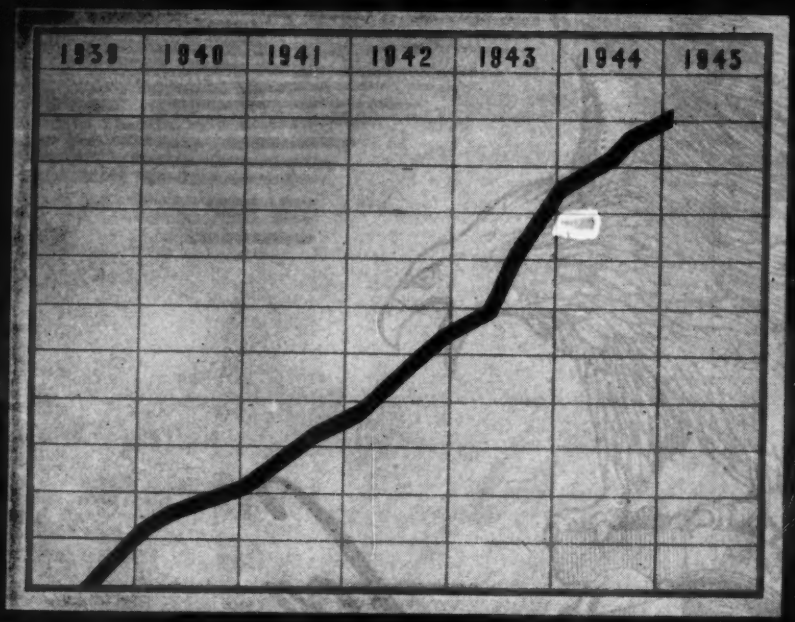
PIONEER'S 300,000th *Life Saving* PARACHUTE

Establishes a production record



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Scientific Engineering and Manufacturing "Know-how"

We take pride in announcing the production of the 300,000th parachute. This is the greatest number of parachutes manufactured by any factory in the United States, and because this was accomplished in the short span of five and one half years — from July 1939 to January 1945 — it establishes an unequalled record.

Behind this production achievement is a dramatic story of research, engineering, and manufacturing "know how". This record is a result of a constant, intensive effort by every employee of the Pioneer Parachute Company to back the war effort and fulfil the responsibility placed upon us by the Army and Navy.

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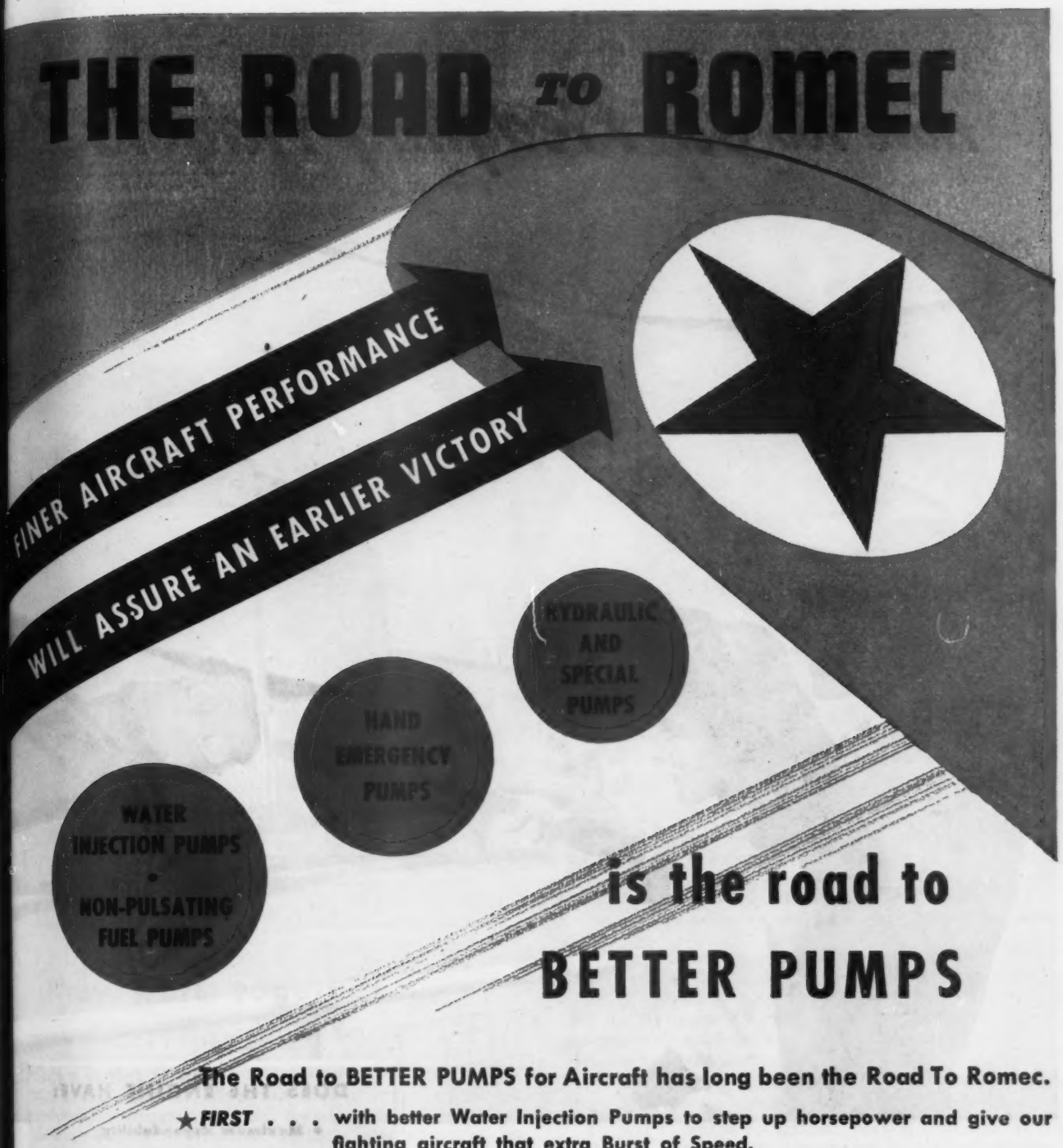
THE ROAD TO ROMEC



is the road to BETTER PUMPS

The Road to BETTER PUMPS for Aircraft has long been the Road To Romec.

★ ***FIRST*** . . . **with better Water Injection Pumps to step up horsepower and give our fighting aircraft that extra Burst of Speed.**

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★ ***FIRST*** . . . **in concentrating EXCLUSIVELY on building better aircraft pumps. Not trying to be jack of all trades.**

★ ***And FIRST*** . . . **long before Pearl Harbor—in pumping the fuel for round-the-world flights—without showing signs of wear, after circling the globe.**

What more can we say about ROMEC PUMPS?

Set Your Budget NOW in support of the 7th War Loan. Then DOUBLE YOUR APPROPRIATION.

ROMEC PUMP COMPANY • 117, Abbe Road • ELYRIA, OHIO, U. S. A.

Have You Got Fledgling Fidgets?

Lots of people have, these days. And, as Uncle Sam turns back more and more of the smaller aircraft that have served the war effort, the restlessness to get back into the air is going to grow.

Just a reminder, then, to check over the powerplant of the plane you buy, whether it is used or whether you wait for a new one.

DOES THE ENGINE HAVE:

- **Maximum dependability**
- **Maximum durability**
- **Maximum economy**
- **Ease of maintenance**
- **Guaranteed availability of parts**

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KINNER MOTORS, INC., Glendale 4, Calif.

Kinner

1919-1945 ★ BUILDER OF DEPENDABLE AIRCRAFT ENGINES FOR OVER A QUARTER CENTURY

BUY AND HOLD WAR BONDS

AVIATION'S BIG FOUR...

MANUFACTURER | OPERATOR | MAINTENANCE ENGINEER | DISTRIBUTOR

They work together ...They buy together

Aviation buying is team buying. There are no individual stars. That's because the four major functions of the industry—manufacturing, operation, maintenance and distribution—are closely interrelated, in fact, interdependent. So closely that it's almost impossible to put your finger on the point where the buying influence of one stops and that of the next starts.

To illustrate: The Douglas, the Boeing, the Lockheed and other giant transport planes are joint products of the manufacturers' engineering and production skill *and* the operation and maintenance experience of the airlines. Power plants, propellers, power plant accessories and other vital components are jointly agreed upon.

Military planes (with their major units) are designed and engineered by both manufacturer *and* operation and maintenance officers of the air forces.

In the design and production of personal planes (and specification of their major parts and accessories) the aircraft service operator has a very real voice.

Throughout aviation this pattern of *common interests* repeats itself.

That is why *Aviation* does not concentrate editorially on maintenance to the exclusion of other interests—nor on manufacturing, nor on operation, nor on distribution.

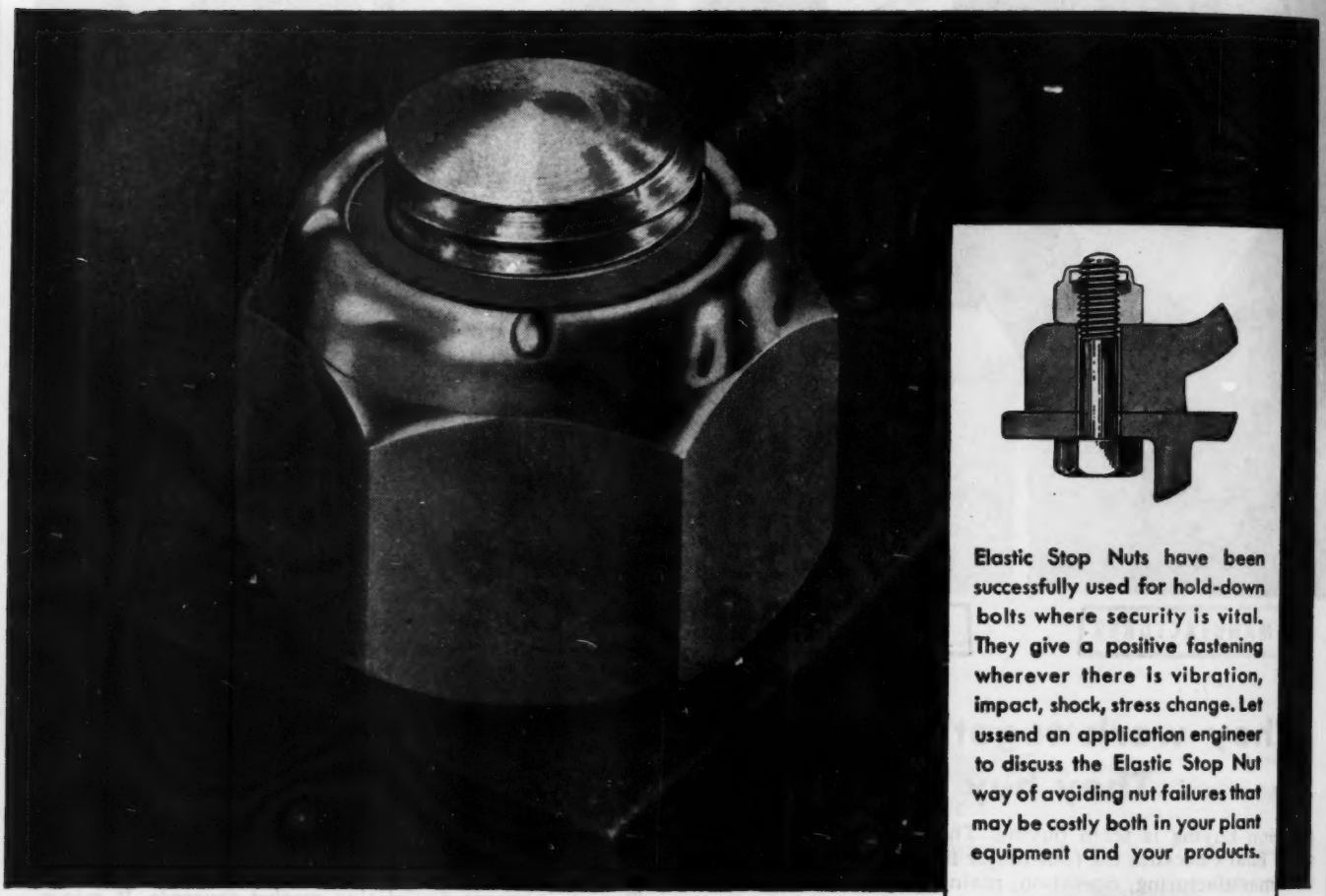
Each month *Aviation* directs its editorial content to *all* the interlocking interests of aviation. To the needs of research, design, engineering and production—to the related needs of operation executives and maintenance engineers—and to the needs of the distributors and aircraft service operators who are today laying the groundwork for an expanding postwar plane market.

We call it *foundation editorial coverage*. It means adequate information directed to an adequate audience.

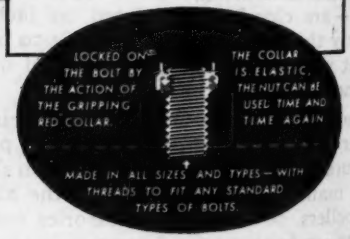
To you it means *foundation market coverage*. It means that each month your advertising is assured of reaching 42,000 paid subscribers who represent *all* the buying interests of aviation.

AVIATION — AVIATION NEWS — AIR TRANSPORT
McGraw-Hill Publishing Co., 330 W. 42d St., New York 18, N.Y.

A HOLD-DOWN *for Keeps*



Elastic Stop Nuts have been successfully used for hold-down bolts where security is vital. They give a positive fastening wherever there is vibration, impact, shock, stress change. Let ussend an application engineer to discuss the Elastic Stop Nut way of avoiding nut failures that may be costly both in your plant equipment and your products.


LOCKED ON THE BOLT BY THE ACTION OF THE GRIPPING RED COLLAR.
THE COLLAR IS ELASTIC. THE NUT CAN BE USED TIME AND TIME AGAIN
MADE IN ALL SIZES AND TYPES—WITH THREADS TO FIT ANY STANDARD TYPES OF BOLTS.

This nut uses its head.

An Elastic Stop Nut carries its own insurance for a positive hold-down fastening — the elastic collar built into its head.

Here's how this device works:

The tough but resilient elastic collar forms itself to the individual bolt threads, grips them so tightly that the nut won't loosen up or back off even under the severest vibration.

Forget about cotter pins, lockwashers or any other auxiliaries when you use an Elastic Stop Nut. That means no chance of leaving off these extras as well as saving time in assembly and servicing.

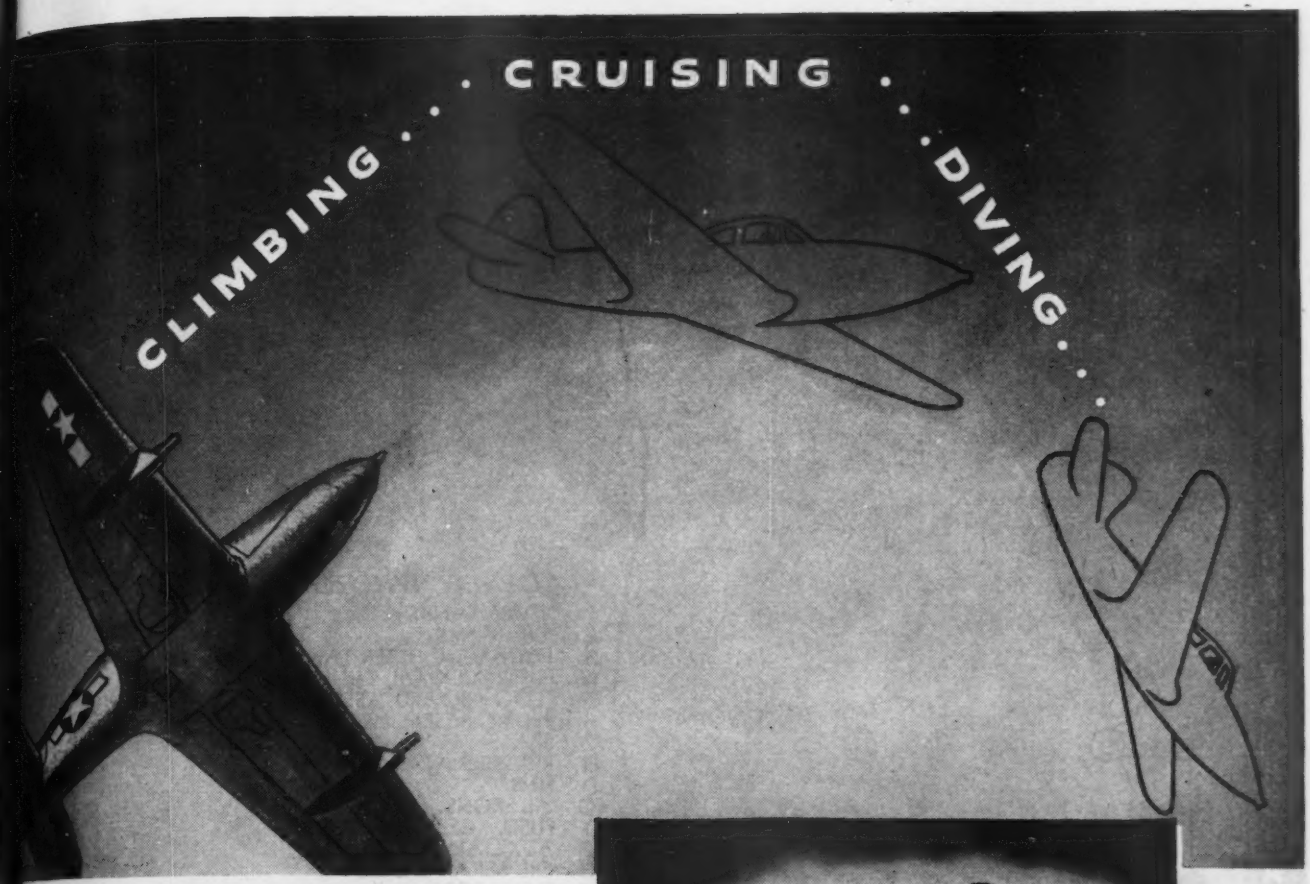
Once on, an Elastic Stop Nut stays on. And it can be used over and over again without losing the grip of its headpiece.

Result: Economy in production and economy in use.

ESNA

TRADE MARK OF
ELASTIC STOP NUT CORPORATION OF AMERICA
Union, New Jersey
and Lincoln, Neb.
Sales Office—1060 Broad St., Newark2, N.J.

ELASTIC STOP NUTS
Lock fast to make things last



. . . CONSTANT TEMPERATURE CONTROL

Liquid Cooled Engine Thermostat. Automatically controls coolant circulated through the heat exchanger. Designed so that valve position unaffected by static pressures in the cooling system, by varying pressure drops across the heat exchanger or control valves, or by changes in altitude.

WHILE he no longer flies it like the old-timers—"by the seat of his pants"—today's plane is probably more than ever a part of the pilot.

He wills himself aloft . . . and his plane soars like a rocket. He dives, he climbs; he cruises as freely as if his heart were an engine and he himself had sprouted wings.

To a large degree, flying facility comes from complete confidence in devices such as Sylphon Aircraft Controls. These rugged, self-powered instruments are responsive to slightest temperature change. Simple in design and construction, utterly dependable, they control the engine coolant, help maintain the constant engine temperatures necessary to efficient performance.

Today, Sylphon Controls work to win the war . . . tomorrow they will be an integral part of machines that go to make a new era of better, more comfortable living.

Write for Bulletin JA-822, describing latest developments in Sylphon Aircraft Controls.

New Movie—"The Story of Metal Bellows" is available to interested executives and organizations. Graphic. Highly informative.

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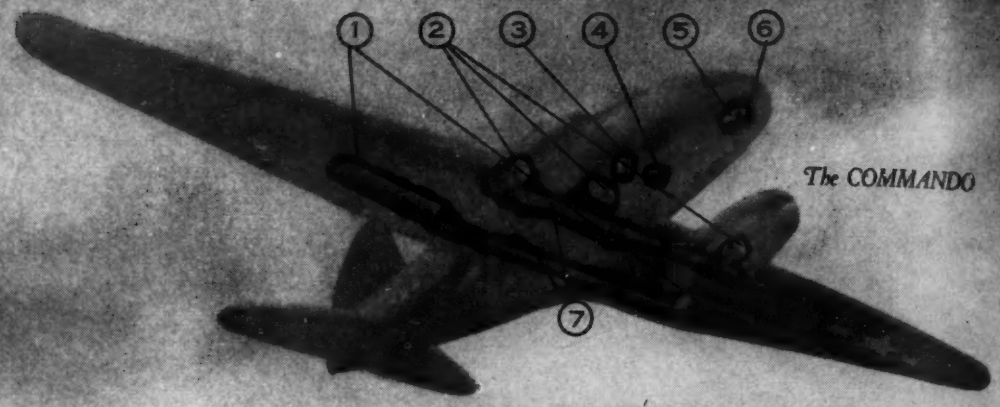

The COMMANDO

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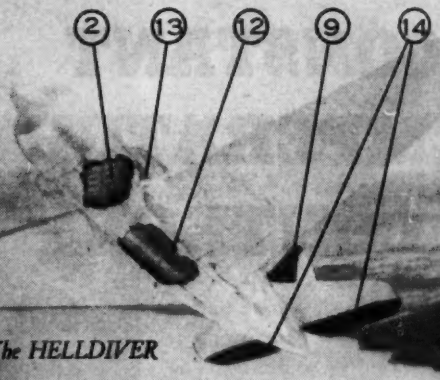
The WARHAWK



The HELLDIVER

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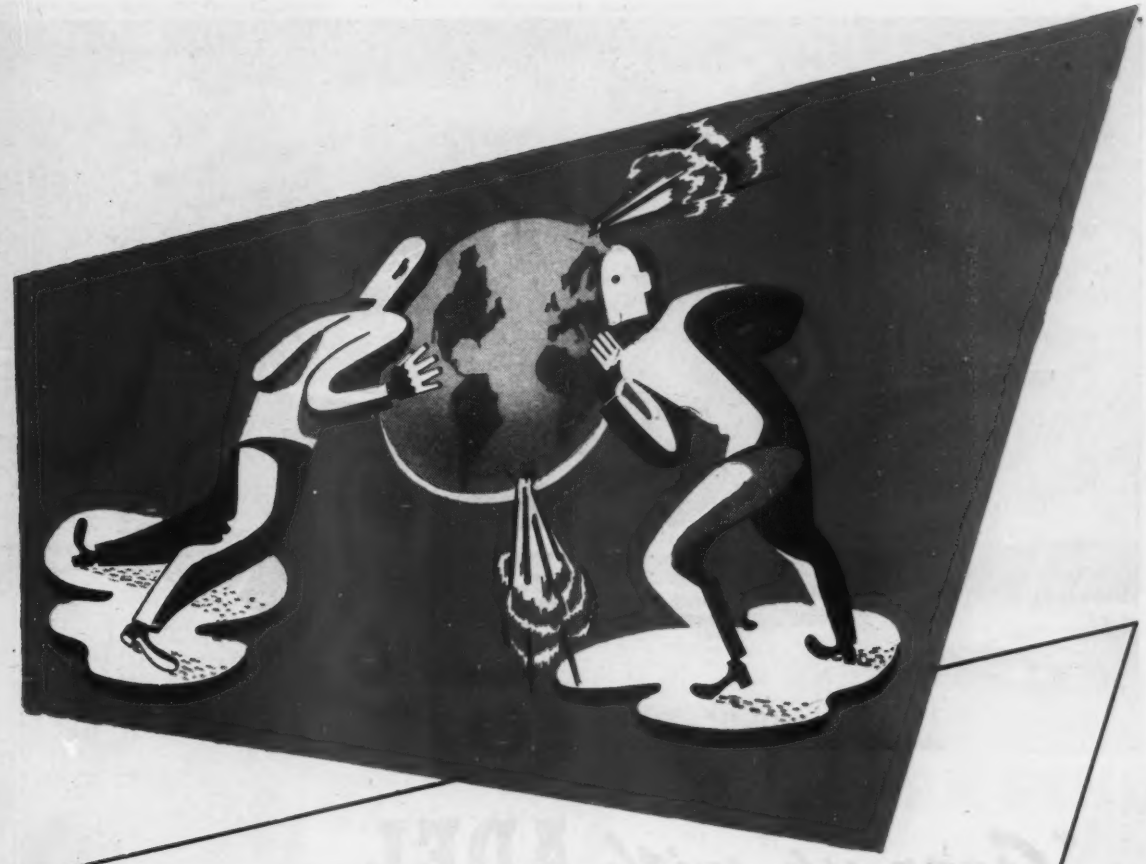
FINS RUDDERS ELEVATORS AILERONS SPARS OIL SEPARATORS



Global shrinking

COME to think of it, part of our business, like yours, is making the world smaller. By telescoping time and space with *speed*. We contribute to the process in two ways. First, hydraulically. With fast-acting power actuators and controls. Precision designed for war-planes, cargo carriers and commercial aircraft that make ponds out of oceans, islands out of continents. Second, electronically. With radio communication equipment that shrinks thousands of miles into an instant. Such as the **Aireon** Type 508 Transmitter for ground-to-plane and point-to-point conversation. It's used by the Army Air Transport Command and commercial airlines to monitor global air traffic, keep planes hopping. Hydraulic or electronic, it's our stuff; designed and built from the ground up by **Aireon** engineers with real technical savvy and produced in plants equipped to handle precision work on a quantity basis. The same combination is available to handle your problems whenever you say.

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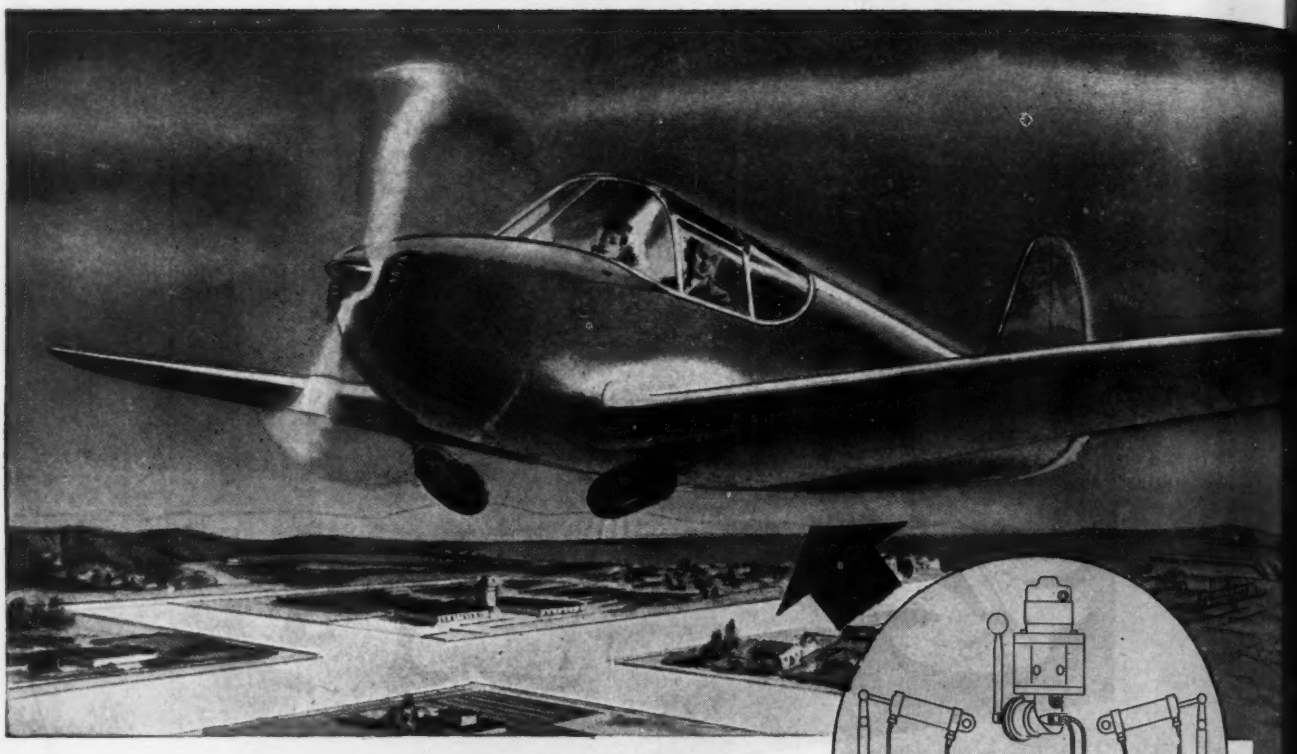


"Gear up" with ADEL

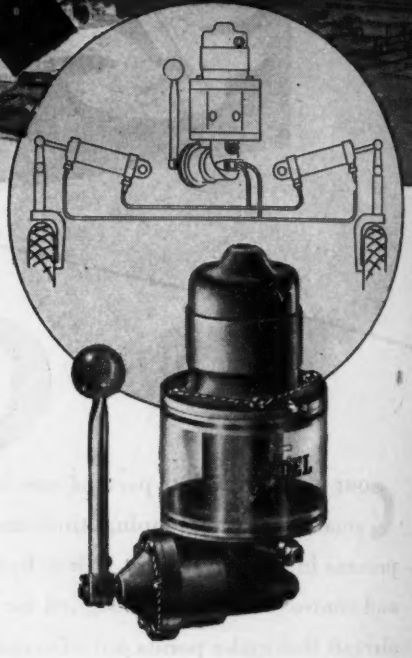
New Power Packages for Light Planes

Designed specifically for the private plane, the new ADEL power package actuates retractable landing gear mechanisms, wing flaps and similar mechanical devices.

A compact unit, easily mounted in small space near the pilot, its electrically driven pump delivers fluid under 300 psi pressure at the rate of .40 gpm with a power requirement of only 298 watts at 12 volts. Its energy capacity is considerably in excess of normal needs of the private plane. Simple to install, it is low in cost and requires a minimum of maintenance for long, trouble-free service.

In this Power Package, ADEL brings to private flying the experience and skill gained in years of manufacturing hydraulic equipment for nearly every leading military and transport plane —tens of thousands of units which have been service tested under every conceivable condition in all parts of the globe.

For full information and technical data write the ADEL office nearest to you.



ABOVE—One of a series of ADEL Power Packages. It comprises an electric gear type fluid pump, visual reservoir, adjustable pressure relief valve, thermal relief valve, a cylinder by-pass valve, 4-way selector valve connected to manual control. Only 4 fittings required to connect. Overall size 4" diameter, 9 3/16" high. Weight filled 4.875 lbs, empty 4.5 lbs.

LOOK TO ADEL FOR PRODUCTS OF *Design Simplicity* AND *Dependability*

ADEL

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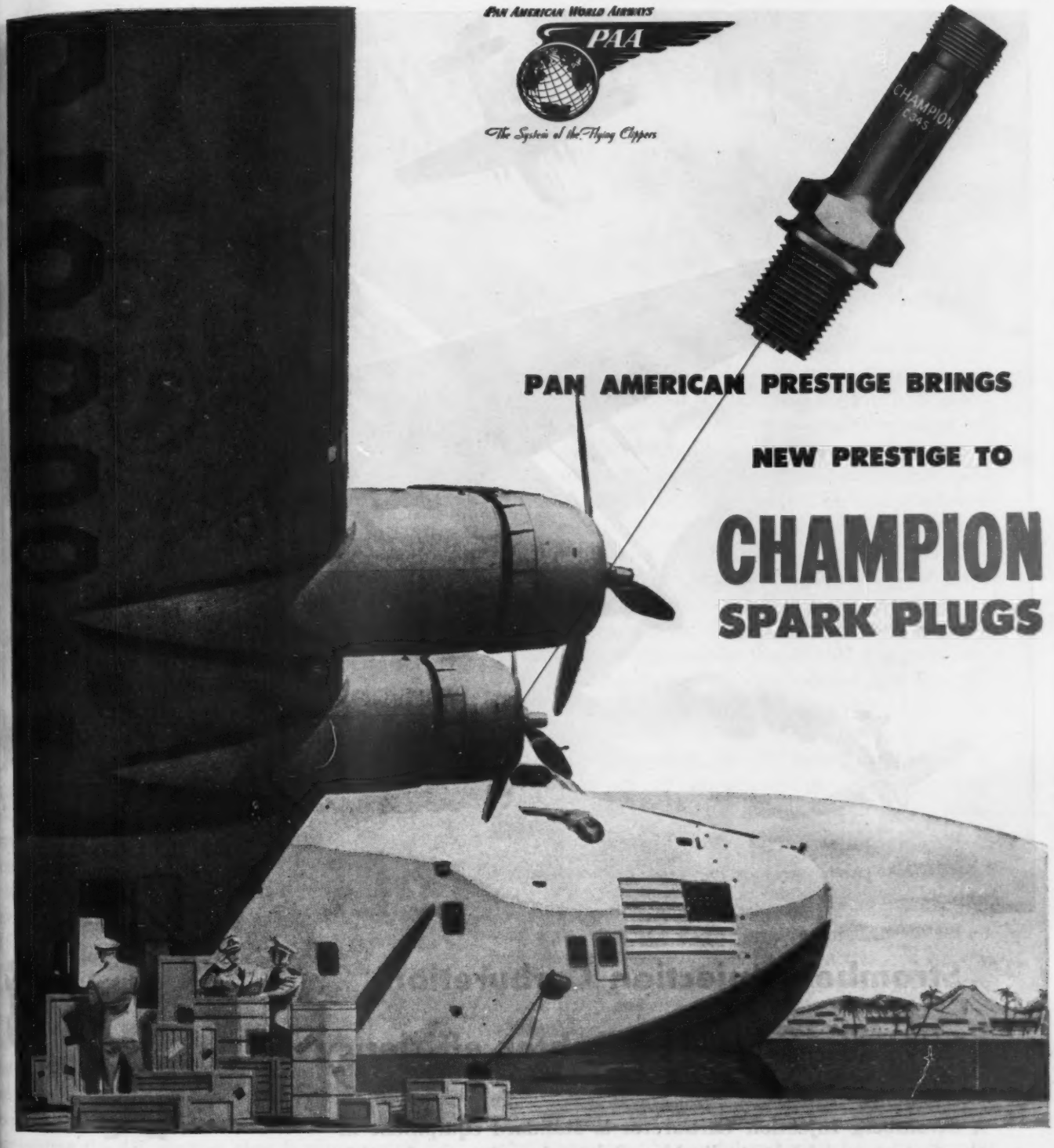


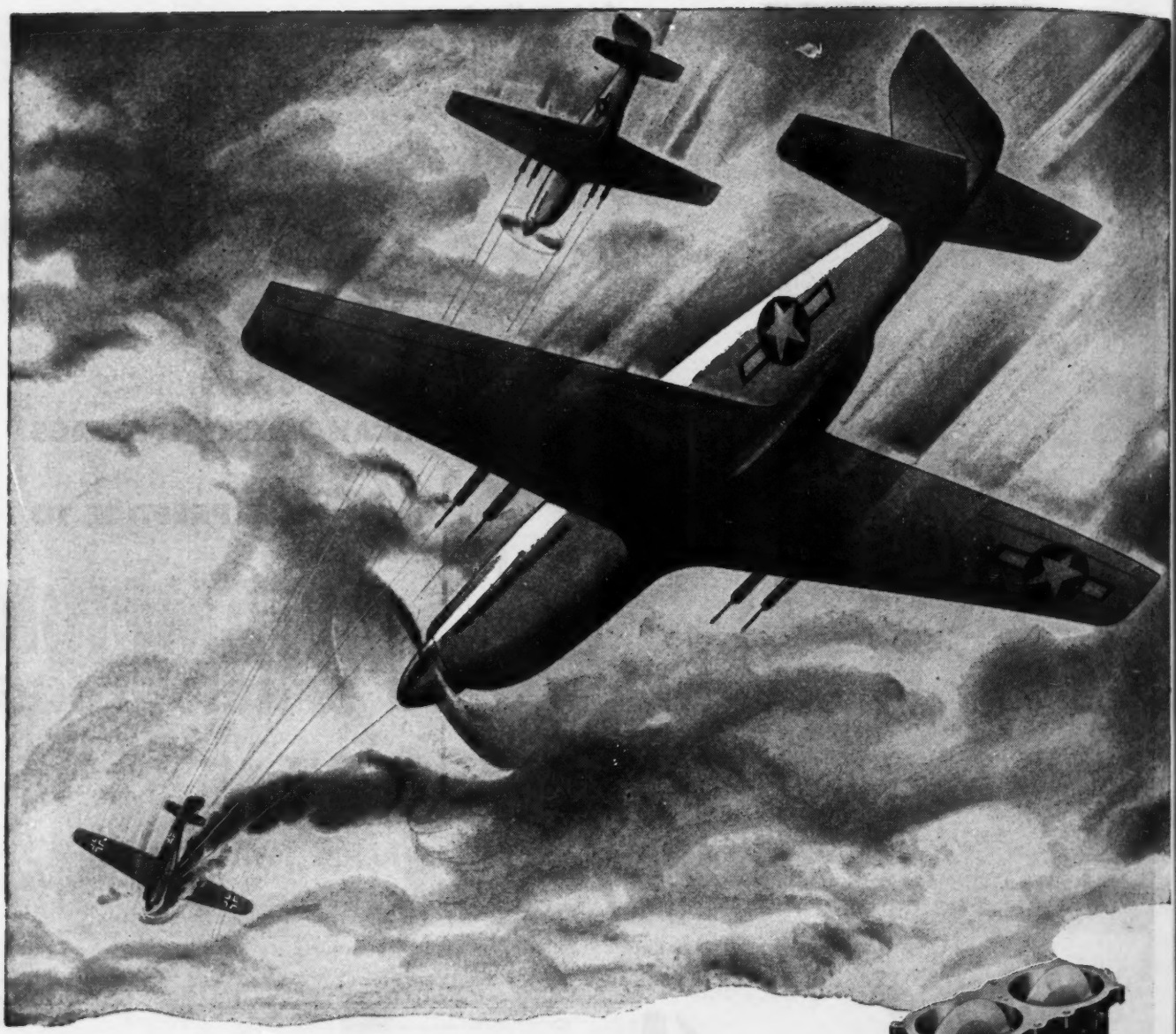
In its far-flung operations to the outposts of the world, Pan American Airways has been operating under stringent wartime restrictions and equipment limitations. It has nevertheless compiled an outstanding performance record in both contract work for the Army and Navy and in maintenance of its own commercial routes.

This achievement bespeaks a painstakingly scientific maintenance and service program. The small but vital spark plug naturally came in for close study because of its direct bearing on engine economy, performance, and dependability. Out of these studies and records emerged conclusive and dramatic evidence of superior performance, longer life, lower costs, lower maintenance and servicing time with Champion Ceramic Aircraft Spark Plugs.

The Champion Spark Plugs for every aircraft engine are blood brothers to those used in Pan American's far-flying clippers. They are products of the same research and engineering, exclusive materials and processes; and, as a result, they bring an extra measure of performance and dependability to every engine. Champion Spark Plug Company, Toledo 1, Ohio.

C26 Unshielded

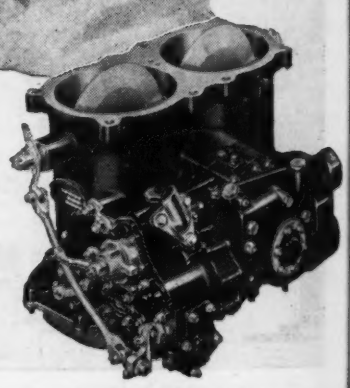
USE CHAMPIONS AND FLY WITH CONFIDENCE



Stromberg Injection Carburetion

"Raises the Roof" of fighter efficiency

A Stromberg Injection Carburetor is standard equipment in the fastest and highest climbing fighter in existence for this excellent reason: The Stromberg Injection Carburetor automatically and instantly compensates for changes in altitude, position, temperature and speed. *The gas mixture is always right for all flying conditions.* And keeping our pilots on top is only one of its advantages. It has notably increased flight range as well. This ability to get more miles from a given fuel load will naturally make these Bendix-built and designed carburetors vastly important to the cargo planes of the future.



FOR TOP-FLIGHT PERFORMANCE

The Stromberg Injection Carburetor has considerably increased the *ceiling* as well as the range of fighting and bombing planes. And Bendix—with the finest research facilities in its field—continues to make improvements. Watch Bendix for the latest advancements in Injection Carburetion.

Bendix PRODUCTS DIVISION

Bendix Aviation Corporation, South Bend 20, Indiana

SUSTAINED CONSTRUCTION ACTIVITY

One Step Toward High Level Employment

IN the 34th editorial of this series, it was pointed out that sustained prosperity, based on high level employment, was a major postwar goal accepted by government, management and labor.

That editorial developed the theme that, if the goal were to be approached without undue sacrifice of our essential liberties, we must forego the search for magic panaceas, and follow the harder but more promising course of analyzing step by step, and industry by industry, the measures that might contribute toward the end sought.

This is the first of a number of editorials following such a particularized approach. It will examine the role of the construction industry in forwarding sustained prosperity.

☆ ☆ ☆

The influence of construction upon the general level of economic activity is important but not decisive. The claim is frequently advanced that major fluctuations of the business cycle might be ironed out by a properly devised and timed public works program; but any examination of the relatively modest contribution of construction activities to total national output will demonstrate its extravagance.

In the twenty years from 1920 through 1939, the value of new construction averaged just over 8½% of the gross national product. If we add repair and maintenance expenditures, the total is increased to a little over 12% of the gross product. But approximately two thirds of the construction of this period was privately initiated, and only one third was represented by government construction, federal, state and local combined. To expect that we can level out the peaks and valleys of our whole economy through manipulating the 4% portion that is represented by government construction is to expect a very small tail to wag a very large dog.

In fact, the record of construction activity in the past has been on the side of disequilibrium rather than stabilization. In boom times construction activity has climbed to relatively higher peaks than those reached by the economy as a whole; in depression periods it has fallen to deeper troughs. Aside from the special work relief program of the depression thirties, the performance of public construction in this respect is little better than that of private. New government construction mounted with the general trend of the boom from 1921 to 1929, thereby adding its weight to the inflationary trend.

Instead, then, of expecting the construction industry to stabilize our whole economy—a task clearly beyond its power—it would seem appropriate to ask that it look to the more attainable goal of leveling out its own violent fluctuations. If this can be done, many of the most vexing problems of the construction field and of its sphere of influence will be mitigated, employment will be regularized in one important segment of industry where the past record has been particularly uneven, and one aggravating contribution to general business instability will be removed.

The achievement of these highly important, if limited, aims will require the thoughtful, vigorous, and concerted cooperation of management and labor in the construction industry, of a variety of governmental agencies, and of those who direct the sources of construction credit. Of the many measures that must be woven into an ordered program, it is practicable here to present only the broad outline of those which seem to offer the greatest potential usefulness.

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1. Stabilization implies the holding of a balance rather than a freezing at a given level. No rigid formula for a most desirable level of construction activity is possible or desirable. However, it may be accepted as a reasonable initial premise, that we could sustain in the future without major distortion something like the 12% ratio of total construction to gross national product that has been approximated in the past. If it is to serve as an useful reference point, such a generalized premise must be subjected to constant testing both nationally and locally. There must be careful and continuous scrutiny for signs of demand saturation, cost inflation, and labor shortages, all danger signals of far greater reliability than any percentage formula.

The first requisite then is the general availability of information along such lines, far more complete and current than has hitherto been at hand. The second is a general will to hold building activity at a level as high as but not higher than we probably can sustain. Once this principle is accepted, the problem becomes one of marshalling all available instrumentalities to forward it.

2. Public construction, although too small to exert a decisive influence upon economic activity as a whole, can

condition construction trends to a major degree. If, in the decade following the war, government construction approximates its 1920 to 1940 average of one third of all construction, its properly timed impact could do much to level out the construction cycle.

To do this most effectively, public construction should be deferred where and when private building is going forward at a satisfactory pace, and should be started when and where private activity shows undue slack. All government construction does not lend itself to such adjustment. But a large portion of it could be held up for the three to five years which, upon past experience, would provide the necessary leeway to counteract the more violent fluctuations in private building.

Such a program presents numerous difficulties both political and administrative. None should be insurmountable, and the results promise to be of sufficient moment to justify the extraordinary effort that would be required to coordinate federal, state and local government programs. Here is an excellent forum for testing whether or not government economic activity can be made to supplement rather than supplant private effort to serve ends upon which all are agreed.

3. Since private building, postwar as in the past, must supply the preponderant share of construction activity and employment, costs will continue to play a dominant role in determining levels of operation. Wartime restrictions have created formidable backlogs of deferred demand for most types of private, and for many of public, construction. Such demand is so great that it almost certainly will provide the impetus for a postwar building boom of several years duration. There is considerable doubt that in the beginning our building trades, dislocated by war and at low ebb, can organize rapidly enough to carry their share of the anticipated general advance.

However, if former patterns hold, building activity, after a lagging start, will soar, costs will mount, and eventually will saturate effective demand with resultant collapse. That, of course, is precisely the sort of a situation we are seeking to avoid. Crucial to this end is the prevention of rising costs or, better still, the reduction of building costs from present swollen levels.

A recent study by technicians of the War Production Board on the outlook for private housing construction illustrates the point. From 1900 to 1940 the number of housing units built in this country closely matched the statistics of new family formation. The former ran considerably ahead of the latter from 1920 to 1929, and fell behind by the same margin in the following decade.

If the market for new houses were to be similarly limited for the period from 1940 through 1949, the effective demand for new housing during the last five years (1945-1949) is estimated at 3,000,000 units. That is after allowing for houses built from 1940 through 1944, and for vacancies, demolitions, and other factors. If, however, prices could be reduced to 1939 levels, the 3,000,000 unit demand is estimated as increasing to more than 7,000,000 units. Since the latter figure is substantially beyond our production capacity for the period, a backlog would be created that would support an effective sustained demand for the subsequent decade (1950-1959) of 1,000,000 units per year, as against half that amount if rents and sales prices mount with increasing incomes.

The precise accuracy of such an estimate may well be questioned. There can be no question as to the general validity of the point illustrated. The progressive lowering of construction costs will stimulate demand in this field as it has in others. Building management, labor, and their suppliers and customers stand to gain from such a result. Unnecessary restrictions against the adoption of improved technologies and increased productivity should, therefore, be removed, whether imposed by codes of government, regulations of unions, collusion of managements, or inertia of workers. Unless there are compelling social justifications such restrictions must be judged harmful to the whole economy.

4. Numerous other measures could contribute substantially to increased and increasingly stable construction activities. Space remains only to stress the importance of careful consideration for the use of credit facilities as a means of stabilization. In recent years the establishment of the Federal Housing Administration provided a needed stimulus to mortgage lending in the field of housing. The modern pattern of long-term mortgages, providing for regular amortization as well as interest, should be a steadying factor in periods of liquidation. However, there appear to be further possibilities for using credit facilities as a brake when construction activity threatens to climb beyond a level that can be sustained. If public and private lending agencies could devise sound means for raising mortgage rates, increasing down-payment requirements, shortening amortization periods and basing value appraisals upon normal rather than inflated costs, they might exert a healthy influence against the tendency of the construction bubble to inflate until it bursts.

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There is no royal road to sustained high level employment. There is not even a single path to assured construction stability—there are many paths, all strait and narrow and all paved with bruising cobbles. This is true for all other major segments of industry.

It is easier to seize upon a magic formula such as monetary control, or deficit spending, or any one of a score of others, than to undertake an intricate task of piecemeal exploration. But only the latter course will lead to prosperity.

President, McGraw-Hill Publishing Co., Inc.

THIS IS THE 35TH OF A SERIES

EDITORIAL

So You're Going to Have an Airport

YOU ARE A MEMBER of the City Council of Coon's Hollow. You have read in the newspapers that aviation is here to stay. Or perhaps a neighboring community's air consciousness is challenging that display by your town. Or maybe you have read that the government is going to spend billions on an airport program. Or you may have lost a son in the AAF or Naval Air Service and you feel that an airport would be the most fitting memorial to the boys from town who will not come back.

Whatever the reason, you have now decided that Coon's Hollow should have an airport. And you have sold your fellow council members on the project. Well, where do you go from there?

This is where you need to call for help from someone who knows something about the aviation business. No matter how much money Abner Zilch has made from his clothespin factory on the edge of town, no matter how sincerely Abner is concerned about Coon Hollow's welfare, he is not competent to advise the city fathers on their airport problems. You need someone who knows the peculiarities of the flying business and knows them thoroughly. The experience of the Civil Aeronautics Authority and the Aeronautical Chamber of Commerce are always at your disposal.

Don't look upon your airport as a facility for your community alone. Look beyond its boundaries and out into the surrounding country or trade area. It is usually desirable to make a survey of the industrial plants throughout the area to evaluate the service that could be rendered by a local landing area. Then you may find that the future will demand two or more airfields. You do not have to build them all at once, nor do you have to build the first one to its ultimate proportions immediately. But set up a sound airport plan for the community and provide for its execution in easy stages.

Many an airport has been outgrown before it was completed. Almost all landing facilities, properly managed and promoted, become too small in due course. So don't go overboard on the initial size of the project but be sure that your plans provide plenty of room for expansion. An excellent plan for an expandable airport is presented on page 182. If your state has an airport plan, tie in with it by all means.

THE VALUE OF THE LAND for the site must be weighed against accessibility to the center of town. A field too far out may be less expensive from a real estate standpoint, but remoteness detracts from the over-all utility of the airport, unless its location happens to fall within a circle of industrial plants outside the city. In any case, good transportation to town must be available or its provision made a part of the over-all airport project. Many a city large enough to know better has invested millions in an airport—and then failed completely to provide adequate ground transportation to connect it with the business center.

Last, but by no means least, don't be too eager to accept a handout from the federal or state government or both. There are many locations where some degree of subsidy is necessary and desirable. But the more sparingly such subsidies are applied the better. We do not yet know the exact pattern of future airport legislation. But where there are subsidies there are usually strings. An airport is like any other business in that it is more likely to survive if it is self supporting.

Many small and medium sized communities have proved conclusively that an airport can pay all or most of its own way. This is the direct responsibility of the airport commission and the airport manager. Great care must be exercised in the selection of the manager, who must be an unusually versatile person.

FIRST REQUIREMENT is proven ability of this man to run a business profitably. Knowledge of real estate and law are tremendous assets. Sales ability and general aggressiveness are vitally important. Familiarity with the aviation operating business is essential. Independence from political influence is a tremendous asset; indeed, every airport commission should be set up on as nearly a nonpartisan basis as possible.

Prime duty of the manager is to attract aggressive, financially responsible, and potentially successful operators as tenants. But few airports are so favored that they can support themselves on aviation activities alone. A lucrative source of revenue can and should be derived from public recreational activities at the airport. Municipal fields should be looked upon as public parks where flying is carried on. Privately owned and operated airports should be activated in conjunction with hotels, resorts, or country clubs.

Cleanliness and comfort for visitors are much too rare at many existing airports. But they are the basic requirements for the paying airport. After you have provided a place where you would be willing to take your own family for Sunday dinner, add a few other attractions for nonflying visitors. Avoid the honky-tonk atmosphere but provide ways and means for visitors to relieve themselves of loose change. Remember, pennies and dimes built the Lincoln Memorial, and vast fortunes for five and ten cent store operators. It is usual to turn over the non-flying concessions to people experienced in this type of selling. The airport manager can't be a superman; he has plenty of other things to do.

These are a few of the general requirements for successful planning and operation of airports. Specialized problems in particular communities must be met as they appear. But, after your airport is properly planned and constructed, its benefits to your community will be based largely upon your ability to operate it with aggressiveness, with sound business methods, and with simple common sense.

Leslie E. Neville

EDITOR

Veteran Re-Employment Pattern Set by United Air Lines

By R. F. AHRENS, *Director of Personnel, United Air Lines*

First airline vet program, now in operation, is designed to speed returning serviceman's readjustment to civilian life, thus promoting both his and company's efficiency and well being.

RETURNING WAR VETERANS want to work and have homes and families. It takes a job to do that. Suitable employment for the millions of servicemen will be a high priority requirement in the postwar period, and furtherance of this country's democratic and prosperous progress may largely depend upon that one thing.

Every business organization, and every community, large and small, has the responsibility to plan enough jobs for all, in advance. Time may be short. Thousands of veterans are returning now. It is impossible to tell when the wars will end and the deluge will be upon us. Relatively few servicemen will be needed as foreign occupation forces. The others will want to hurry home, and the late President had promised that they shall.

These aspects are reflected in the opinions and policies of United Air Lines, which has tried to assume more than its share of leadership in re-employment planning. It is true that the airlines face a period of expansion after the war, and it may thus seem an easy matter for United to meet job seekers confidently. But many other industrial fields, notably those of automobile production, rail car manufacture, many lines of durable goods and equipment, industrial and home construction, and numerous services—all look forward to expansion and increasing employment.

But merely enrolling employees is not enough. Every applicant must be made to feel welcome and needed. His problems and his ambitions must be listened to. His changed qualifications must be analyzed. He must be given a physical examination, and if he is handicapped he must be placed where he can work and produce with satisfaction to himself and the company, permanently, or during a recovery period. If a suitable place cannot be found for him at United, the company assumes a certain human obligation to him—whether he was formerly employed or not—to encourage him, and to refer him to other prospective employers in the community.

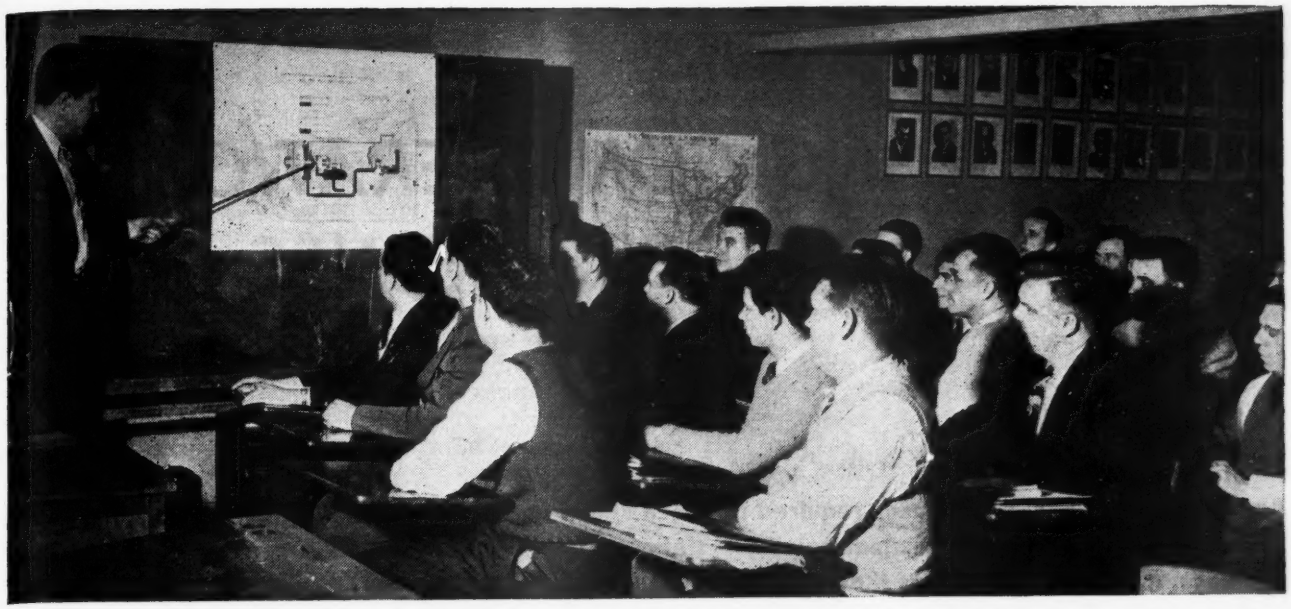
All that takes time, organization, and proper facilities. United Air Lines, after months of preparation, is ready with its returning veterans' program. Heading the personnel department is the writer with E. H. Johnson as assistant director of personnel, D. A. Medland as employment manager, R. E. Peterson as assistant to the director of personnel, regional directors in the eastern and western divisions, and a director at the Cheyenne maintenance and modification base.

United's personnel and employment programs have been handling a total force of about 8,000 people and employing new personnel all along. This group includes about 500 flight captains and first officers, plus 150 in overseas military operations. More than 100 United pilots are in military service, and about 135 employees in service have received some pilot training in the armed forces.

From now on for an indefinite period, United's personnel management will concentrate on receiving ex-servicemen and women and trying to place them in jobs in which they can make the most of their prewar and war-acquired skills, and it is continuing checks on each person. A rough guess is that the company will employ around 7,000 men and women in the next two years, including turnover, and a substantial portion of that number will be from the armed services.

The company's key personnel policy is that every man and woman is an individual, every one different, and every one must be treated as an individual This does not mean that personnel officials have to pamper all their people, figuratively holding their hands. Instead, most employees go ahead on their own. In fact, any intelligent personnel direction really has a nice prob-

Vets returning to UAL get tailor-made reindoctrination to acquaint them with changes occurring during military leave. Here, E. H. Johnson, assistant director of personnel, reviews airway traffic control procedures with Lt. Cmdr. Russell Van Tyle, who flew Chicago-Denver-Cheyenne route for nine years before entering service in 1942.



War veterans returning to employment with United Air Lines are carefully fitted into company's extensive classes—such as mechanic helper's upgrading class shown here—for indoctrination into latest techniques. Program, under direction of Author Ahrens, calls for close personal contact with every individual veteran re-joining company to help speed his readjustment to civilian life.

lem of leaving its people alone, as well as giving them the proper attention.

The company's interest in its employes is set forth in this statement on firing: "We feel that there are always two sides to a 'firing,' and we want the details. When one of our employes is fired by a supervisor, he goes through the exit interviewer, who determines whether the individual can be re-allocated to some other assignment, or whether it is judged mutually beneficial to let the individual go elsewhere. We think of a 'fire' as a pretty serious matter, particularly to the employee concerned; we believe each case deserves serious consideration."

United feels that anybody worth hiring is worth going to considerable trouble to keep happy and productive. The time to minimize trouble with employees is at the time of hiring them. Yet, because United has about 500 classified jobs, a wide variety of personalities and skills can be used, so long as the applicants are persons of good character and goodwill.

Toward former employees returning from service, the company feels obligations above and beyond the requirements of the "GI Bill of Rights," a Congressional Act which says that employers must re-employ veterans except for good cause. There are loopholes in this law, but United feels that it and all employers are bound to adhere strictly to principles which they know to be right and fair. It will not be easy for employers to do justice to their civilian employees, their own returning veterans, and veterans whom they did not formerly employ. This is why United is studying and working on the problems, and is willing to give additional details of its experience and findngs to any other employers who may ask for it.

The re-employment of war veterans presents several hard problems in human relations, sometimes called psychology. We have no professional psychologists in adjoining offices to give us professional advice. This should not reflect on PhD's in the least. United's personnel staff got its know-how by years of study and experience, and we try to mix that with common sense.

One of the difficult problems is the youngster who was filing cards or running errands before the war. He comes back as a 23-yr. old captain or a major, having reached an estimable standing among his fellows and having been paid more money than he ever dreamed of. Perhaps he has gained some experience useful to the company, but most of it is not.

He wants to be an executive. Certainly he cannot be put back on his old job. Sometimes it takes two or three days of tactful discussion, but most likely, in the end, he will answer his own questions and realize that if he were placed arbitrarily above his actual qualifications, he would be asking for a fall.

As of May 1, a total of 44 men have been re-employed under United's veteran program. Three or four of these have been in combat. In addition, more than 300 veterans of this war who were not with United previously have been hired.

From our experience, most men subjected only to military training are not seriously maladjusted. But many who have seen combat, especially for long periods, may be temperamental and unable immediately to accept routine. Cases of this type will require continuing attention for a while. For these men, patience will bridge the gap between military and civilian life.

All veterans returning to private life will have been cleared by the War Veterans Board. This means that all will be considered mentally and physically capable of holding jobs. But selective placement of physically handicapped men will be necessary. Some of the men have lost arms, legs, or an eye; some will have diseases of the circulatory or nervous system; many will have healing-ulcer conditions. Col. A. D. Tuttle, United's medical director, says that many of them will fit into the company's wide variety of jobs. If they need medical treatment, a job will be sought that will enable them to take treatment without being absent. In fact, United has been employing men rejected by the armed services all through the war. The records show that handicapped men have rated exceptionally high both in production and in attendance. One returned veteran, for example, had to be placed in a job different from that for which he was qualified. But he became increasingly adjusted, and in six months he was doing his regular job, successfully and happily.

In another case, a service man had suffered a disability which made him unable to pass the physical requirements of the job he wanted. He was placed in another department where his skill enabled him to serve as a "prac-

(*Turn to page* 245)

OPERATING CONSIDERATIONS FOR FEEDER AIRLINES

PART II OF A SERIES

By JAMES G. RAY, *Vice-President, Southwest Airways Co.*

Analysis of the delicate balances required between speed and complete area coverage—while maintaining safety, comfort, convenience, and economy—shows that it may be necessary to combine pickup and landing operations.

TO BE IDEAL, any plan of feeder airline operation should satisfy all the basic requirements of any other transportation service, such as safety, reliability, convenience, comfort, coverage, economy, and speed.

The first requirement, of course, is safety. Local or short haul air transport must be as safe as any other means. It seems probable that a local carrier would suffer more loss of patronage from an accident than would a long haul carrier, because it operates within a much smaller geographic area where more of its potential customers would hear about the accident.

Second only to safety is the matter of reliability. Feederline service must be thoroughly dependable. In the past, air transportation has been handicapped because of frequent schedule interruptions due to weather and other causes. Feeder operations should be even more reliable than long haul transport because of the relative ease with which a competitive agency can be selected. Also, a large percent of feeder patrons will be making connections to more distant points and if these connections are missed, a great deal of ill will may be created.

Convenience is of great importance—much more than in long haul transportation; ease of traveling by some other means makes this so. Schedules must be provided at the time the passengers want to travel. They may willingly wait many hours if they are making a long journey—but not when the trip is short.

This convenience can be provided only by frequent schedules. The full traffic potential of a route cannot be developed by one or two schedules per day. Good routes, where a sizable population has a substantial need for air services, will quickly justify hourly schedules during part of the day.

A study of the relationship of the amount of traffic generated to the number of schedules shows that for the smaller cities and towns of the country, those having two daily schedules generated more than twice as many passengers per capita as did the towns having only one schedule per day. And the towns having three schedules generated three times the per capita traffic of the single-schedule towns. This data, given in Table I, seems to indicate that even in trunk line operation if a town or a route can justify air service at all, it should be given at least three schedules daily. For reasons given above, this principle is more applicable to feeder than to trunk lines.

Reasonable standards of comfort and personal service must be provided, through these need not be equal to trunk line standards. The trips will be relatively short, and somewhat lower standards will be tolerated by the traveling public accustomed to less comfortable accommodations on branch line trains.

Complete coverage is another requirement of feeder service. It must furnish transportation to most of the towns to which the people living along its routes may want to travel This has been a handicap to the trunk lines in the past—not enough towns have had air service. Establishment of feeder routes will, of course, provide a much larger number of destinations, and this will in turn, increase the usefulness of air service to all cities, including those on the present air map.

But in feeder operations, each town should be furnished frequent service to every other town in the areas. This cannot be done by the so-called skip-stop type of operations where each schedule lands at only a few of the towns along a route with later schedules alternating to the remaining unserved towns.

One pointed requirement—which should not be considered least important—is that feeder service be economical. It is, of course, granted that for some time to come air transportation, for most local journeys, will cost more than ground; but it is very important that this difference be kept as small as possible.

Though all these requirements must be satisfied, speed is the thing that sells air transportation. People will fly because they want to get some place faster than they can by ground transport. Any proposed feeder air service must offer a substantial saving of time in order to achieve acceptance of higher fares and thereby attract sufficient traffic to be self-sustaining.

Thus we have some of the basic operational requirements that must be

TABLE I—Relationship of Daily Air Passengers To Number Of Daily Schedules For Towns Under 50,000 Population Receiving Air Service In 1940

Number round trip schedules	Number of cities	Average population	Total daily passengers	Passengers per 1,000 population	Passengers per 1,000 population per schedule
1	31	18,415	116.9	.2047	.102
2	13	23,459	134.7	.4417	.110
3	22	23,868	340.1	.6477	.108

met in furnishing a feeder airline service. Fortunately they can all be satisfied.

It was pointed out in my previous article (Apr. AVIATION) that a substantial volume of traffic on a feeder route is possible if a number of towns are served. The volume from each town is small, hence only by adding several towns together can sufficient traffic to support a route be obtained. Naturally, the more towns included the larger will be the volume of traffic.

There are other reasons to include all of the towns along a given route. The same reasoning that justifies service to one will apply to all the others. If a route is to be flown to serve two or three larger towns, the several smaller intermediate towns also should be served. Their need for service is proportionately as great, and to include them would require little extra flying because they are located along the route anyway.

A large part of the justification for feeder airlines is the need of the smaller towns for airmail service. Though

airmail now moves overnight between our larger cities, making possible a next morning delivery in nearly all of them, this service does not generally apply in the satellite towns. By the time the mail arrives at the trade area's terminal airport in the early morning hours, gets to the downtown Post Office, is reworked, and then is distributed by surface transportation to the smaller towns in the area—it is late afternoon, too late for business mail to receive attention that day.

All towns along a route need this mail service, even towns that are too small to support a landing for passengers. Past experience has proved that towns with only 500 to 1,000 population will generate enough mail to justify service if the aircraft, due to route circuity, does not have to fly too many extra miles.

As a matter of fact, service for airmail alone can be justified on many routes, using nonstop pickup devices to expedite schedules and to lower operating costs. It would be justified by increased revenues to the Post Office Department which would pay for the flying and for the other increased postal costs in handling the mail.

But a mail-only service does not satisfy all the needs of the satellite towns for air service. If the service is to be complete, passengers must be carried. And though passengers have been "picked-up" in military operations by the use of the same pickup devices used for mail, we will have to land for them in airline operation—at least for quite some time. Thus, the pick up-only operation is ruled out for most routes because the service it provides does not satisfy all the needs of the smaller towns for air service.

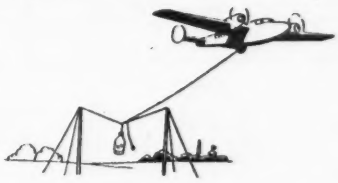
Now we are committed to a type of operation which requires that landings be made for passengers whenever necessary. This does not mean that landings will be required at every point of service along a route. A combination type of service, where pick up gear is carried on board passenger carrying planes, would permit landings wherever necessary for passenger, and at the same time mail and express could be picked up at all other points.

The type of operation where landings are made at each point to be served has a number of disadvantages. One is that costs are increased. Each landing results in additional wear and tear on the plane and its engines; further additional gasoline and pilot time are used. But the greatest disadvantage is the loss in over-all speed resulting from frequent landings. It becomes very difficult to maintain schedules that are fast enough to have advantages over ground carriers.

The best way to save these landing-time losses is not to land at all. This principle has influenced the development of our present trunk airline system and accounts for the very few new towns added to it in the last decade. When this principle is applied to feeder airlines better speeds can be maintained; but, as we have seen, furnishing service to every second or third town along a route does not solve the problem of providing air service where it is needed. Only a part of the need for air service would be taken care of that way. Also, the smaller towns need frequent service to all other towns in the trade area—service which the so-called skip-stop method cannot provide.

Thus it is apparent that we cannot take the operating methods presently used on trunk airlines and apply them to a feeder airline. Along most routes, towns that can justify passenger service are found to average about 25 to 30 mi. apart with quite a number of still smaller towns, needing mail and express service, located between the larger ones. The only type of operation that seems capable of furnishing a satisfactory service along such a route is the combination service referred to above. With this type operation airmail and air express service can be given all the towns, plus passenger service to towns having sufficient traffic potential and suitable airports.

As a further advantage, this combination operation permits saving time otherwise spent in landing at regular passenger landing points when these landings are not actually necessary. Pickup stations would be installed at all regular landing stops, and mail and express service would be furnished without landing when there were no passengers for that station.



Arguments against the combination service hold that passengers would object to riding through the pickup maneuver. But closer examination reveals that by eliminating a number of landings, the passenger would be furnished a safer, faster, and more comfortable service than would be possible if landings were made at all points.

If there were ten towns on a feeder route, no one would argue that it would be too dangerous to make regular landings at every stop. The pickup maneuver and the landing maneuver are exactly the same down to about 10 ft. from the ground, and then everything that occurs below 10 ft. in the landing maneuver is eliminated. Everything that occurs in the takeoff maneuver before an altitude of 10 ft. is reached also is eliminated. Pickup and takeoff maneuvers become identical above 10 ft.

There seems to be little doubt that passengers will appreciate service that will not only save them time, but will also eliminate the hazards, inconveniences, and discomforts that occur in the landing and takeoff maneuvers below 10 ft. Practically all the undesirable things about a landing occur below this level.

Actually, the pickup is accomplished by changing the attitude of the airplane from its gliding to its climbing position. This change is gradual and does not cause excessive accelerations. Several hundred passengers have been flown through simulated pickups as a test to determine their reaction. These tests showed that the passengers seldom know when the pickup was made. They would, of course, know the aircraft was getting close to the ground, but it certainly meant no more than approaching the ground for a landing.

Functioning of the pickup gear it-

TABLE II—Comparison Of Methods Of Operation For Hypothetical Feeder Route Showing Proportionate Amounts of Service, Relative Speeds, And Revenues By Methods

Town Trade Center	Population A & B	Population C	No. passengers A & B	No. passengers C	Mileage A & B	Mileage C	No. Landings A	No. Landings B	No. Landings C	No. Schedules A & B	No. Schedules C	Time Lost Per Schedule (Min.) A	Time Lost Per Schedule (Min.) B	Time Lost Per Schedule (Min.) C	Actual Speeds A	Actual Speeds B	Actual Speeds C	Fare Per Schedule Mile A & B	Fare Per Schedule Mile C	Revenue Per Trip A & B	Revenue Per Trip C
A	7,381		1.9		22		1.4	5		5		1.4	5		150	150		52.6C.	32.2C.	$11.57	$7.08
B	20,072	20,072	5.1	5.1	28	48	3.8	5	3	5	5	3.8	5	5	140	120	150	50.7	32.2	14.19	9.02
C	7,740		2.2		15		1.6	5		5		1.6	5		125	108		45.6	27.1	6.84	4.06
D	6,637		4.6		24		3.4	5		5		3.4	5		126	106		43.4	27.1	10.42	6.50
E	52,383	52,383	18.0	18.0	37	73	5.0	5	3	5	5	5.0	5	5	125	107	136	38.8	27.1	14.36	10.03
F	6,653		5.0		13		3.0	3		3		5.0	5		118	103		34.7	15.2	4.51	1.98
G	4,421		3.6		24		2.7	3		3		4.5	5		115	103		26.3	15.2	6.31	3.65
H	3,824		3.1		16		2.3	3		3		3.8	5		112	101		20.3	15.2	3.25	2.43
I	11,321	11,321	9.1	9.1	21	69	3.0	3	3	3		termina			111	100	133	15.2	15.2	3.19	3.19
	120,432	83,776	52.6	32.2	200	190	26.2	37	9			28.5	40	10						$74.64	$47.94

Method A—Combination pickup and landings where necessary for passengers.
Method B—Landing at all nine towns.
Method C—Landing at three largest towns only.

self does not give a noticeable jolt to the aircraft; passengers would not know when the actual pickup was made. As a matter of fact, pilots flying the presently operated pickup service sometimes miss contact with the ground station and usually do not know it until told by the pickup gear operator.

Even with the combination operation it will be necessary to do everything possible to get through the landing stations with the least loss of time. In present trunk line operations this time loss is much greater than can be tolerated on feeder lines. It is believed that with an aircraft especially designed for rapid ground handling and with some modifications of present operating procedures, the loss of time per landing can be held to not more than five minutes.

Such aircraft should be of high wing design so the fuselage can be close to the ground with free and unobstructed access to all compartments. Several doors should be provided to allow all items of cargo to be loaded at the same time. Special loading equipment, such as ladders, portable platforms, and passenger loading stairs, should not be necessary because these things take time and man-hours to put into place. It will not be necessary to service the aircraft at all of the landings, but special servicing equipment should be provided at refueling points.

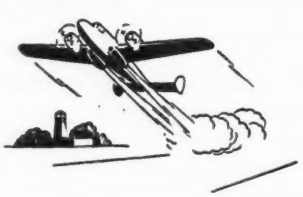
A good part of the time lost in landing is consumed by the long taxi distances between the landing point and loading ramp. These taxi distances can be shortened, especially at the less congested airports in the smaller towns, by adopting as nearly an on-course landing and takoff procedure as possible.

The aircraft should have a tricycle undercarriage that will allow cross wind operation. Most landings should be made straight in without circling the field, and most takeoffs should be made on-course with the aircraft traveling in the direction of the next point of service from the beginning of its takeoff roll.

The aircraft should have good maneuvering characteristics at relatively slow gliding speeds. This will increase the pilot's accuracy in spot landings. Thus he can land close in and cut taxi time from the end of the landing roll to the loading ramp. This accuracy can be increased by providing a means of varying the over-all drag of the aircraft. Some form of controllable flight brake with sufficient capacity to vary and to steepen the glide path would be of great assistance to the pilot and would pay for itself in time saving.

A corresponding saving can be made in the time required to taxi from the loading ramp to takeoff position. Here again the approach is to eliminate as much taxiing as possible. The run should be started from the closest place to the loading ramp from which a safe takeoff can be made. Taxiing all the way back just to use all of a runway that is longer than necessary is a waste of time. So is an airport that is too large.

From takeoff position a sufficient amount of runway must be ahead to permit either a safe takeoff should one engine fail at a critical time, or roll to a stop before the end of the runway is reached in case the pilot elects to shut down the other engine and remain on the ground. This safety requirement is necessary, but it does impose an operating penalty because it substantially increases the required runway length for takeoff.



The aircraft, of course, should be designed to have as good takeoff characteristics as possible without sacrificing too much payload and cruising range. But a more promising way of cutting down this takeoff run is by use of rocket power to supply the lost thrust from the failed engine for a few seconds until the aircraft has cleared the obstacles surrounding the field and can continue flight on the remaining engine. It is believed that a jet of sufficient size to supply the thrust of one engine would not be too large or too heavy to be carried as emergency equipment. Its use would permit operation out of much smaller airports, which is very important in feeder operations, as well as allow faster operating procedures on large airports by decreasing the ground handling time.

By using pickup gear in the combination operation, we have eliminated a large number of landings without curtailing service to any town along the route. By a slight modification of operating procedures the time loss per landing can be decreased sufficiently to permit operating schedules that will compete successfully with existing ground transport schedules. Thus we have arrived at a practical method of airline operation for feeder routes.

Of course feeder routes can be operated to furnish mail and express service without landing (by use of pickup gear) or they can be operated to furnish passenger, mail, and cargo service by making regular landings at each point served. But for the reasons given, it seems logical that the combination service, retaining a substantial part of the speed advantage of a nonstop operation, yet satisfying the small town's need for passenger service, is the most suitable for feeder operations.

Table II analyzes advantages and disadvantages of the three most practical methods of operating the hypothetical route referred to in last month's article. Populations and the number of passengers per day for each of the nine towns are from the previous arti-

cle. Mileages are assumed, as are the 180-mph. cruising speed and 5-min. time loss for each landing. Five schedules are projected for the first part of the route, three for the remainder. The number of landings necessary to serve a town is arrived at by multiplying the number of passengers by .75. If this figure is greater than the number of schedules, of course the latter is used. The revenue columns assume a 5c. per mi. fare and that all passengers will fly to the trade area center.

When service is furnished to only the three largest towns, there is a serious revenue loss—from $74.64 to $47.94 per flight. Fifty-six percent more revenue is available when all towns are served, either by landing or by the combination method. Eleven percent higher over-all speeds can be maintained by the combination method than by landing at each town.

The expected traffic and need for frequent schedules helps to determine the proper size of the aircraft. A third factor is the cost per seat-mile. This cost figure, of course, is lower for larger aircraft. But if a given route has a traffic potential of 50 passengers per day, for example, it would not be possible to carry them all in one large 50-passenger plane flying only one schedule. Probably at least five schedules would have to be flown to give service to all 50. Still better service could be rendered, probably carrying more than 50 passengers if ten daily schedules were flown. However, there is a limit to the process of flying more schedules with smaller planes because the seat-mile cost becomes too high.

So a compromise must be reached. Studies indicate that, in the beginning, the correct feederline plane size is one to accommodate about 12 to 15 passengers and about 600 to 1,000 lb. of mail and cargo. With this size, passengers

can be flown at a fare of around 5c. per mi., yet relatively frequent flights can be scheduled without exceeding the traffic potential of the route.

To satisfy the exacting requirements of safety, precise and complete flight procedures must be worked out to cover every phase of the operation. Every contingency must be anticipated and a safe procedure adopted without leaving anything to chance.

The principles governing present trunk airline operating procedures are directly applicable to feeder operations. However, the flight procedures themselves are not always applicable; the operation is different and allowances must be made.

Probably the most pronounced difference is that feederline work is a low level operation. Where towns served are only 15 or 20 mi. apart, there is no reason for climbing to altitude between them, but flying at low levels will require extra precaution.

Any collision indicators, radio altimeters, and other modifications of radar equipment that become available after the war, will greatly facilitate this exacting flying.

Most feeder airline flying will be contact. All the points to be served cannot have the equipment necessary for instrument approaches—the expense would be to great. So flights approaching these points must be contact.

Though actual scheduled operations where flying is done only under contact rules have given a remarkably high percentage of on-schedule flying, greater reliability can be obtained if instrument flying is included, wherever possible, as part of the flight procedures. A number of airports along each feeder route, and probably both terminals, will have radio ranges. If part of a route has below-minimum weather, the flight often can be continued on instruments to some point beyond the low spot where a let down can be made and contact flight resumed for the rest of the trip.

Inclusion of this flight procedure would definitely increase operating percentages. Because of the very great need for reliability of schedules in feeder operations, it should be adopted. No extra operating costs would be involved, because emergency instrument flight would be required anyway for safety. Emergency instrument operations would be necessary, since any contact flight can be forced on instruments by a combination of adverse weather and other circumstances. Should this occur, the pilot must have the instruments and radio equipment needed to fly to a nearby range and get down.

In some ways a feederline pilot will have things easier than a trunk line pilot. He will fly a much shorter route and can get to know its landmarks much better. For the same reason, he will also know more about the vagaries of weather along the course. Because the flights are short, there will be less chance for the weather to change enroute.

Though the special knowledge and training of a feeder airline pilot will be somewhat different, the excellence of his training must be just as great as that of a trunk line pilot. There can be no doubt about his knowing his flight procedures or following them.

The pilot, regardless of how good he is, must have the support of an effitient and highly trained operating organization. Dispatchers must be provided to supervise and control all flights. They must have a communication system through which this control can be exercised; also, a weather reporting and forecasting service on which the pilot and the dispatcher can rely in formulating their flight plans. Maintenance must be of the highest caliber because of the high safety standards and operating percentages that must be attained.

Of course a traffic division must be provided to book traffic to support the operation. The work of this division will be complicated because a substantial number of feeder passengers will be making connections with trunk airlines for flights to more distant points and will want through reservations made.

Thus it becomes apparent that running a feeder airline is a full scale operation. It isn't something a school operator can do in his spare time. When a common carrier undertakes transportation of passengers, he assumes obligations that must be fully met in the safest possible manner.

These obligations and responsibilities make it necessary that the operator employ highly-trained technical personnel, which will be expensive. To do business in a manner that will gain public confidence and furnish sufficient service to attract the patronage necessary to make the venture profitable will require an operating organization of considerable size.

Accordingly, it is seen that a number of routes must be operated as a unit to provide sufficient flight miles to absorb these costs. In other words, a feeder operation cannot be small, for then it would be to expensive.

In next month's article, Mr. Ray will discuss operating costs of a feeder airline and the various factors that effect them.

WHERE DO THOSE GAS TAX DOLLARS GO?

By JOHN R. WEST

— Every place but where they should, declares this vitally interested personal flyer, who sounds a call to arms to stop diversion of state funds from sorely needed airway facilities.

GASOLINE TAX PRACTICES, as prevailing today in the majority of our 48 states, represent a serious detriment to both personal and commercial aviation. In some respects these taxes are ridiculous and, if not changed soon, may result in seriously hampering a great and rapidly developing phase of American life.

Before developing the reasoning behind that statement, however, it should be pointed out that it is not taxation in itself which is opposed—it certainly is as fair to tax aviation fuel as it is automotive fuel. Strenuous objection is raised, though, to the present method of taxation and the present use of the revenues thus gained.

The federal tax of 1½¢ on gasoline is legitimate—there is no quarrel with that. It is with the varying state taxes that the aviation industry and personal flyers are, or should be, concerned.

In the first place, it is felt the original premise on which state legislatures assess taxes on airplane fuel is erroneous. Modern flying cannot be limited by state boundaries; the crossing of several state borders in the course of a few hours flying puts aviation in the realm of federal—not state—jurisdiction. Therefore, any tax on aviation fuel should be levied wholly by the federal government and not the individual states.

Let us examine the existing state taxation setup and point out the wide discrepancy between the theory behind it and the actual practical workings of those tax procedures.

In 1942, the latest year for which figures are available, each of the 48 states except North and South Carolina were levying taxes ranging from 2 to 7¢ per gal. of airplane fuel. The income for the preceding year from these taxes totaled $5,428,000.

Thirty of the states work on a partial or total refund plan. That is, an aircraft operator pays his tax when buying the fuel, then is entitled to a rebate —varying with each state—if he has the time and patience to fill in the required forms and can stand up under the red tape. But there is one question which defies answer: If the states are willing to refund such money, why collect it in the first place?

The remaining 16 tax-levying states do nothing about refunds. They simply take the money and allocate it as they wish. Sometimes, it goes into an aviation fund. More often it goes into highway funds, which have little to do with aviation. Other times it goes into education or relief funds, with the result that tax money collected on aviation is not used for aviation development.

In justice to some states, exceptions to diverting the tax funds should be pointed out. Tennessee, for example, has done an outstanding job of seeing that aviation tax money has been well spent on aviation development. Florida will, without too much reluctance, refund 7¢ per gal. if the gasoline is 78 octane or higher; Kansas will return its 3¢ tax if more than 40 gal. are bought each time. This practice, as with New Mexico's 50-gal. limit, automatically eliminate rebates to virtually every personal plane operator.

Kentucky adds a fancy touch for commercial operators in rebating its 5¢ tax. Such operators must deposit a $1,000 bond and file their receipts on gasoline purchases before the 15th of each month, or no refund. The personal flyer gets no refund no matter what he does. Michigan will allow a 50 percent refund to those engaged in commercial interstate operations.

Virginia's refund method is a matter for experts. There they refund the 5¢ tax *if* the gasoline is purchased for interstate use, but a complicated sliding scale arrangement cuts down the refund according to the time flown in Virginia air. Wyoming's tax law has a subtle touch; here the personal flyer can get a refund of 2 of the 4¢ tax *if* he buys more than 10,000 gal. per month.

It is thus evident that today's varying state aviation gasoline taxation amounts to pretty much the same thing —getting the money by one means or another. Scanning the muddled picture, one is tempted to wonder if the states simply saw a means of getting revenue or if they were afraid personal flyers would find a uniform tax system too boring on cross-country trips.

Use of this tax money for anything but aviation purposes acts to strangle an industry which needs financing for expansion. It needs the money paid in by taxes for expanding facilities, training, and research so that further growth can be stimulated. The country's automotive industry would be nothing compared to what it is now if, in the early days, tax money had been diverted from highway construction as it has come to be.

Personal flying today is in much the

same position that the automobile industry was some 30 yrs. ago, and the country stands to lose gravely if flying is hedged and cramped by the reckless draining and incorrect use of its money in state taxation.

The rebate procedure which the majority of states follow would be ridiculous were it not vicious in its practical applications. The states take the money, then offer to give it back. Inefficient, this, but not too bad. However, what actually happens is that only the commercial airlines do get refunds—it means too much money not to. But it involves needless expenditure of valuable time on the part of both airlines and tax-supported clerks. The personal flyer or smaller operator rarely gets his refund, simply because it is uneconomic to spend the required time and effort.

In fact, few personal flyers ever file for refunds. I recently checked 30 airplane owners in the Los Angeles area and found that one man filed regularly for refunds in California but not in other states; eight had filed once but had not tried again because the money involved wasn't worth the cost in time and irritation. The other 21 had never filed at all.

These are but a few typical examples by which the various states reap millions of dollars by default. Even that wouldn't be too unfair if the money thus accumulated was used for aviation purposes. But it is all too frequently diverted to funds which have little or no connection with aviation. California, one of the nation's top personal flying states, has been collecting personal property taxes on aircraft and, by default, many hundreds of thousands of dollars through aviation gasoline taxes since 1923. It has never, to my knowledge, invested a single cent in any project for aviation.

One might well question the furor about the states taking all this money if, as indicated, it isn't worth the bother of filing for refunds. Besides the principal involved, there is this:

In 1941 there were about 20,000 privately owned planes in the United States. It has been estimated that such ownership will increase ten times to reach 200,000 aircraft within a few years after the war ends. Other estimates say there will be 300,000 to 500,000 privately-owned aircraft within the first decade of peace. Real money is involved even if these figures are not reached.

The federal and state taxes on aviation gasoline for 1941 amounted, as has been pointed out, to nearly $8,000,000. With 500,000 planes in the air these taxes might easily reach the $200,000,000 mark. We risk being trite in remarking, "that ain't hay."

Now it should be reiterated that there is no argument here with federal taxes. Federal taxation is as sensible as aviation is national in scope. Furthermore, the federal government spends funds accumulated by such taxation on essential aviation projects all over the country.

But, under existing conditions, about $140,000,000 of the possible $200,000,000 will be going to the states. And the states have no unified program for developing airways facilities. Few make any constructive effort in that direction at all. Many mince no words in allocating aviation tax funds to any department that may be a bit frayed at the cuff.

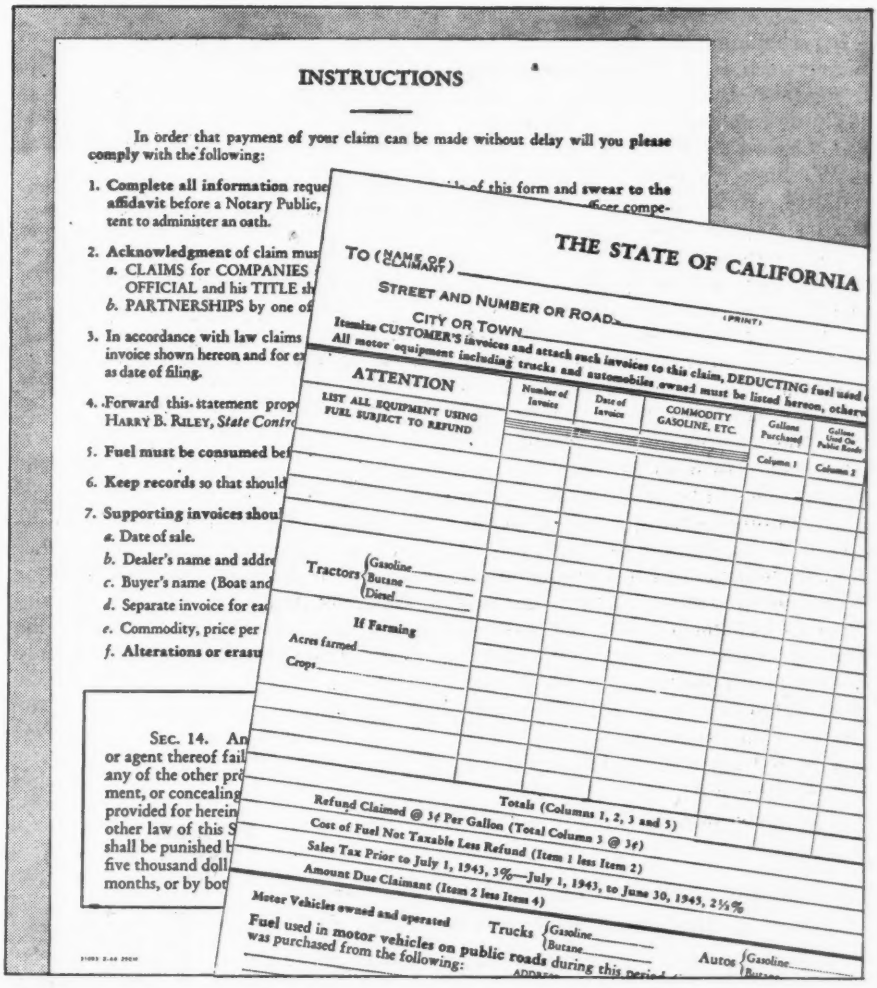
Rhode Island, for example, imposes a tax of 3¢ per gal. and drops the money into that yawning maw known as "general fund." Pennsylvania ups the tax to 4¢ and tags the money for highways and relief. Alabama and Georgia raise the ante to 6¢—for highways and education. Louisiana wins the pot with a 7¢ levy which goes into the highway fund. Refunds are simply not considered in any of these states.

Aviation, particularly personal flying, needs these funds. Airway authorities have estimated that 25,000 to 30,000 landing facilities alone will be needed for personal flying within the next ten years. That means airstrips, airparks, and airports. The cost for building an adequate postwar landing facility has been estimated at $50,000. Simple multiplication shows why we need the tax money spent on aviation projects, $1,250,000,000 of it. We who are interested in a constructive future for private aviation in this country can hardly afford to allow the money we pay out in fuel taxes to go unchallenged into general or miscellaneous state funds.

We not only need all our own tax money for private aviation growth, we will need the help of the federal government—or state governments—if there is continued insistence on taxing aviation fuel.

But how much better off aviation and the country as a whole would be if the people and their elected representa-

(*Turn to page 247*)



INSTRUCTIONS

In order that payment of your claim can be made without delay will you please comply with the following:

1. Complete all information reque... of this form and swear to the affidavit before a Notary Public, ...ficer competent to administer an oath.
2. Acknowledgment of claim mus...
   a. CLAIMS for COMPANIES ... OFFICIAL and his TITLE sh...
   b. PARTNERSHIPS by one of...
3. In accordance with law claims ... invoice shown hereon and for ex... as date of filing.
4. Forward this statement prop... HARRY B. RILEY, *State Contro...*
5. Fuel must be consumed be...
6. Keep records so that should...
7. Supporting invoices shou...
   a. Date of sale.
   b. Dealer's name and addre...
   c. Buyer's name (Boat and...
   d. Separate invoice for ea...
   e. Commodity, price per...
   f. Alterations or erasu...

SEC. 14. An... or agent thereof fail... any of the other pro... ment, or concealing... provided for herein... other law of this S... shall be punished b... five thousand doll... months, or by bot...

THE STATE OF CALIFORNIA

TO (NAME OF CLAIMANT) _____ (PRINT)

STREET AND NUMBER OR ROAD _____

CITY OR TOWN _____

Itemize CUSTOMER'S invoices and attach such invoices to this claim, DEDUCTING fuel used ...
All motor equipment including trucks and automobiles owned must be listed hereon, otherw...

ATTENTION LIST ALL EQUIPMENT USING FUEL SUBJECT TO REFUND	Number of Invoice	Date of Invoice	COMMODITY GASOLINE, ETC.	Gallons Purchased Column 1	Gallons Used On Public Roads Column 2
Tractors {Gasoline / Butane / Diesel}					
If Farming Acres farmed Crops					

Totals (Columns 1, 2, 3 and 5)

Refund Claimed @ 3¢ Per Gallon (Total Column 3 @ 3¢)

Cost of Fuel Not Taxable Less Refund (Item 1 less Item 2)

Sales Tax Prior to July 1, 1943, 3%—July 1, 1943, to June 30, 1945, 2½%

Amount Due Claimant (Item 2 less Item 4)

Motor Vehicles owned and operated — Trucks {Gasoline / Butane} — Autos {Gasoline / Butane}

Fuel used in motor vehicles on public roads during this period ... was purchased from the following: ADDRESS

Hundreds of thousands of dollars of aviation gasoline tax money collected by states goes for uses other than aeronautical development due to out-and-out restrictions or to plethora of red tape, Author West shows. Typical of means of accumulating tax money by default are involved refund applications, such as this from his home state.

LET'S BE HONEST WITH OUR CUSTOMERS

By CARL FRIEDLANDER,
Vice-President, Aeronca Aircraft Corp.

***Carl Friedlander's** interest in matters aeronautical covers more than 15 yr. of continuous service in the industry, both as pilot and manufacturer. As vice-president of one of the "Big Three" lightplane manufacturers, he naturally has a large stake in the industry's future, a future threatened by the danger of having its potential customers misled. In the accompanying article he tells—without pulling any punches—what must be done to protect the plane producers' future.*

FEW MEN EVER FULLY FORGET the thrill they got out of their first appearance in long pants. They could hardly tear themselves away from the mirror. What a man! There wasn't anything he couldn't do.

We at Aeronca believe the lightplane industry is something like that admiring youth. Private aviation has climbed out of knee pants, but it has been spending considerable time admiring itself in its new long trousers. It has also been dreaming a bit and declining to contradict that old wheeze that mirrors don't lie.

We think it's time personal flying walked away from that mirror and faced the hard world that confronts every youth or youthful industry. It may be quite a wrench. A stumble or two is almost certain. But let's do it.

The healthy, strapping youth that was the prewar lightplane industry has gone to war. And that tough job must be satisfactorily settled first of all. But like many other young men who will return to civilian life, our industry should be realistic about what it has to offer, what kind of job it can do for its employer—the public.

Wars breed cynicism and skepticism. This is not the time (if there ever was one) to kid the public about postwar private flying. True, thousands of persons are confident that the air age will follow the peace. We heartily agree. But we insist that the public not be fed the stuff of which dreams, followed by nightmares, are made.

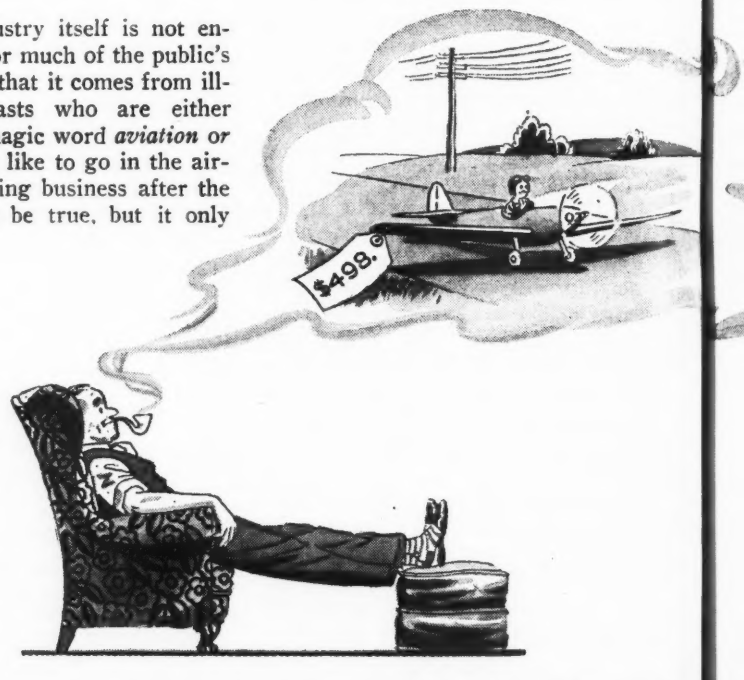
The point may well be raised that the aircraft industry itself is not entirely to blame for much of the public's misinformation; that it comes from ill-advised enthusiasts who are either trading on the magic word *aviation* or who think they'd like to go in the aircraft manufacturing business after the war. This may be true, but it only increases the industry's responsibility to itself and to the public to make sure that its potential customers are given the honest facts. It calls for industry-wide realism in all public contacts to insure that the personal plane's utility and usability are correctly presented.

Surveys conducted by Aeronca show that nearly 60 percent of the light, personal planes in postwar America will be bought by rural dwellers. Another 10 percent probably will be purchased by suburban residents. The remaining 30 percent will be accounted for by metropolitan dwellers.

Why is this? Here's at least one answer: The rural residents know they can use their lightplanes for business much of the time. With planes they can quickly get to town for business, they can quickly secure sorely-needed repair parts; dust crops; make erosion surveys; check range fences; plant seed; or simply dispel isolation by getting from "nowhere" to "somewhere" rapidly. It's the high utility of the lightplane that makes sense to them in their every-day working lives as well as in those periods devoted to vacations and pleasure.

The rural dweller also knows, as does many a suburbanite, that he or she can land and take off from open areas near home—again, for work or play. And in most every case, he has a barn or equipment shed that is practically a ready-made hangar.

Those living on the fringes of cities realize they probably will have to drive a short distance to use their



Grandiose, impossible promises can lead only to a disillusioned, distrustful public and a seriously-hurt manufacturing industry. Here's a prominent lightplane producer's program to avert such conditions.

personal planes. But that's nothing new. They like to drive anyway, and they usually have to if they shop or catch commuting trains.

Those reasons for owning a lightplane are sound. John Q. Public finds they add up. That is, they do now. But how long will such reasoning endure if people begin to wonder whether half the things they hear about lightplane flying really are true? Such things as the combination automobile-and-plane, or the tastefully landscaped airport nestling in the shadow of downtown city buildings where, 'tis said, the lady looking for a new hat or the businessman rushing to his next conference may park his plane?

Americans are a nation of doers. But they know, deep down inside, that some things just ain't so. And if they get too many of those improbabilities tossed at them, they are going to wonder—and then distrust what personal fiying can do for them.

We believe our industry has a tremendous responsibility to the public. Many people may not know an aileron from a slipstream, but they've been sold on aviation and want to participate in it. However, they won't want to for long if first they are dazzled and then awakened to a bitter reality. We must be honest in acknowledging that there are some things that lightplanes will never be able to do, just as there are things which are impossible for any other specific means of transportation.

This is no alibi for any possible lack of aircraft development, for we feel our industry has done an unparalleled job of cramming decades of improvements into months—and that it can continue to do so. Rather, it is an urgent plea for dissemination of accurate information on what airplanes can and cannot be expected to do.

to the necessity of putting all we've got into producing better planes for less money and with steadily increasing utility. And I, for one, know it can and is going to be done.

Most of us in aviation read what Henry Wallace, new Secretary of Commerce, had to say before the Senate Commerce Committee regarding the future of personal flying. He declared that the goal of a large (and presumably personal) airplane industry can be achieved only if the government lends a helping hand. We could bear to know more about just what that means.

Federal aid, as everyone knows, was lent to our railroads and canals when they were experiencing their growing pains. Federal and State financing helped immeasurably to build good roads on which the automotive industry prospered. And lightplane utility will be greatly enhanced by government aid in laying out and building airports and landing strips.

But there can be a limit to anything. And we have abiding faith in private aviation's ability to work out its own destiny as did its predecessor in personal traveling, the automobile.

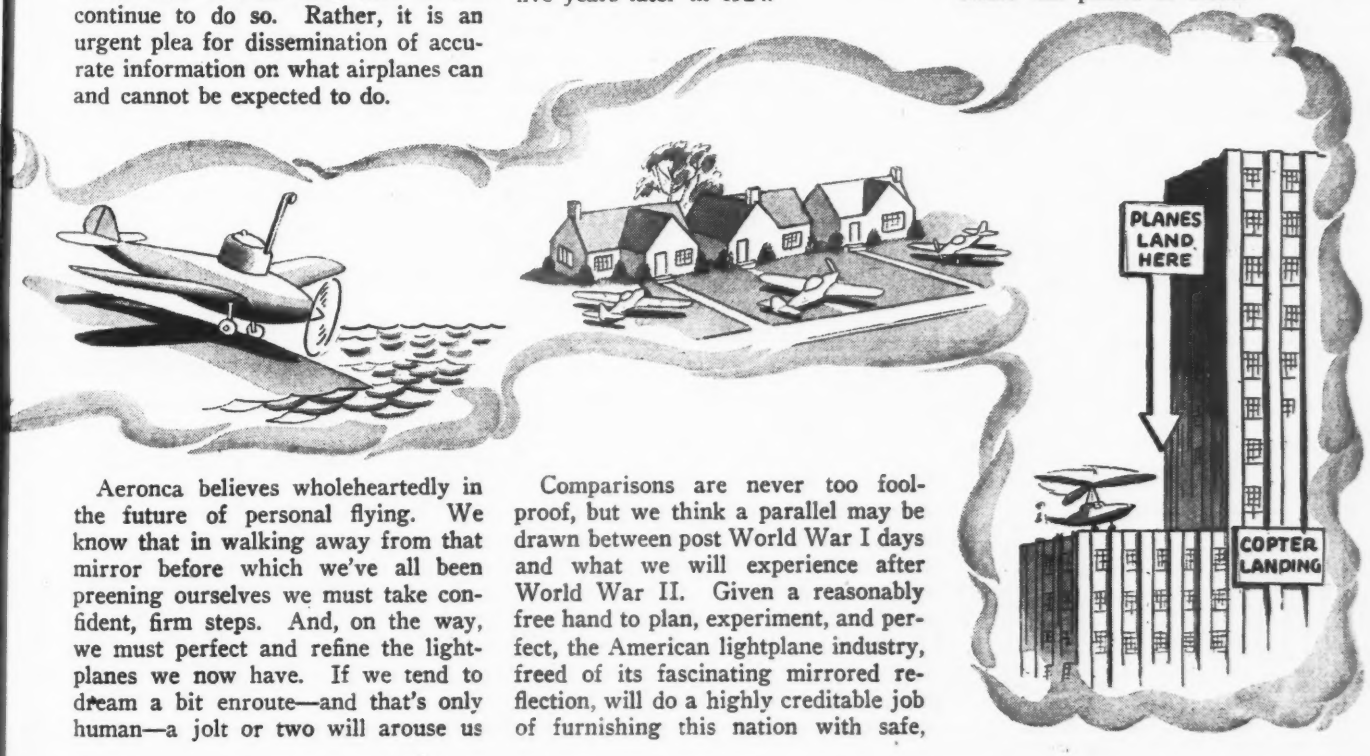
In this connection, it is strange but true that it is almost impossible to determine the yearly increases in highway construction during the early 1920's. But from what many of us remember, the first few years of this century's third decade were not marked by the smooth travel afforded by our prewar highway network. And yet the number of passenger cars produced and sold in 1919 was almost tripled five years later in 1924.

comfortable, economical-to-fly planes.

We believe that the government can and should lend its aid in creating many new landing facilities for the private flyer. That help can be tendered veterans and ex-war workers in many ways, including financial aid in setting themselves up in business on a small airport for the sales and service in personal flying—which in motoring is situated in show rooms and garages on Main Street. We at Aeronca know that we must help these men and women to the limit of our experience in the lightplane industry. And, most of all, we must not kid them or ourselves that the millennium in flying, is any nearer than other dream worlds.

A four-letter word—*Jobs*—is going to be the principal topic of conversation for some time to come. But we have no fear that this country will fail to solve its postwar problems. Sure, they look and are tough. But America did not acquire its high standard of living, working, and playing by postponing the solution of tough problems. And we in lightplane aviation can't do it, either.

The time is almost here when personal flying will have to prove whether or not it rates those long pants. If we act our age, and draw steady aim on the future, we're all set to do big things in a big way. And we've got the whole country behind us, because there has never been a time in American history when such an overwhelming enthusiasm for one type of travel has been so evident. With that backlog of interest and goodwill, lightplane aviation cannot miss if it doesn't kid either the public or itself.



Aeronca believes wholeheartedly in the future of personal flying. We know that in walking away from that mirror before which we've all been preening ourselves we must take confident, firm steps. And, on the way, we must perfect and refine the lightplanes we now have. If we tend to dream a bit enroute—and that's only human—a jolt or two will arouse us

Comparisons are never too foolproof, but we think a parallel may be drawn between post World War I days and what we will experience after World War II. Given a reasonably free hand to plan, experiment, and perfect, the American lightplane industry, freed of its fascinating mirrored reflection, will do a highly creditable job of furnishing this nation with safe,

FINANCE

Our financial editor's annual survey shows that the government is getting more airplanes for less money . . . industry's reconversion reserves are better . . . inventories are down slightly . . . the tax bill far exceeds prewar gross incomes and even though Congress could improve our manufacturers' tax situation, the—

Industry's Financial Position Shows Fundamental Gains

By RAYMOND L. HOADLEY, *Financial Editor, "Aviation"*

NO LONGER need it be said that the aircraft industry faces a desperate fight for postwar survival. For the industry definitely turned the corner last year. Not only was its war effort carried to new production heights in 1944 but the industry also made marked progress in laying the foundations for the reconversion and adjustment period that lies ahead.

A composite picture of the financial status of 17 representative companies shows that the average 1944 earnings of the aircraft manufacturers were slightly higher than in 1943, although not up to 1942 levels.

A continuation of the present satisfactory earnings pace seems indicated in the forepart of 1945. In fact, some companies that had severe cutbacks and major retooling tasks last year are currently doing better than a year ago.

Some companies like Douglas, Republic, and Ryan had larger unfilled orders at the close of the first quarter than ever before. But what will happen in the latter part of this year depends, of course, on the daily changing status of war needs. As distances shrink in the Pacific many of the identical plane types used in European operations may be employed against the Japanese. As matters stand today, nearly every major plane manufacturer is building at least one plane that is a good bet for service in the Pacific war.

The general pattern will involve the gradual concentration of aircraft production in the plants of the aircraft industry itself. Thus 1945 should prove a good year in most respects. And aircraft production bids fair to retain its ranking for one more year as America's No. 1 industry.

This prediction is predicated on the fact that many companies have been able to issue their reports earlier; in fact, we have the picture three months sooner than was the case last year. Renegotiation and other special problems have held up reports of other producers.

Here, in a nutshell, is the way the industry's financial cards stacked up at the beginning of 1944:

Of foremost importance is the fact that larger postwar reserves were salted away than in 1943.

Inventories were decidedly lower. Bank debt, current assets, and current liabilities also declined.

Cash for the average company was higher than the high taxes owed.

Dividend payments increased a bit, and profit margins on record sales continued to be among the lowest of the nation's great industries.

Let us consider a more detailed survey of the aircraft financial facts of 1944 and their relation to the postwar future:

The outstanding fact that can be gleaned from 1944 operations was the sharp reduction in inventories, even in the face of much higher deliveries. Inventories of the reporting companies aggregated $403 million last year, compared with $530 million in 1943

THREE-YEAR COMPARISON OF

	Sales			Net Income			Postwar Reserves		
	1944	1943	1942	1944	1943	1942	1944	1943	1942
Aeronca	$7,220,866	$12,078,638	$3,263,758	$205,957	$204,546	$165,620	$55,000	$158,000	$213,699
Aviation Corp	61,259,997	68,436,010	45,530,638	3,106,179	2,670,192	4,723,894	600,000	1,400,000	2,000,000
Beech	90,103,000	89,826,000	59,592,953	2,705,481	2,216,596	2,417,819	•	•	•
Cessna	40,386,000	70,729,401	11,782,060	1,102,000	2,208,000	738,202	none	831,568	1,586,000
Consolidated	960,016,000	800,578,000	831,295,000	12,424,000	12,279,000	20,875,000	6,500,000	13,100,000	19,600,000
Douglas	1,061,407,485	987,687,196	489,781,985	7,685,227	5,952,257	9,229,620	8,789,000	6,950,000	32,740,000
Grumman	323,749,331	278,695,001	143,155,930	6,944,877	4,643,200	2,535,847	2,000,000	1,300,000	9,979,000
Interstate	24,412,484	8,403,508	•	733,595	138,380	172,831	249,000	none	249,000
Lockheed	603,363,664	669,152,490	460,233,000	4,522,848	7,988,420	8,163,721	1,057,000	9,000,000	10,057,000
Martin	533,400,444	598,072,796	337,556,000	4,909,572	2,988,456	6,658,809	14,500,000	10,000,000	24,500,000
North American	718,003,499	509,139,600	253,226,119	8,389,967	6,790,323	7,370,626	7,000,000	5,000,000	14,451,000
Northrup[1]	88,045,089	69,791,844	32,983,762	603,516	1,249,535	3,044,741	163,000	•	582,000
Piper	3,230,087	4,679,507	4,947,749	157,823	210,883	115,865	33,000	162,000	195,000
Republic	369,593,425	282,581,687	•	2,812,186	3,025,954	1,105,061	1,450,000	2,844,000	5,294,000
Ryan	40,085,433	25,357,541	16,306,888	703,345	597,312	556,444	25,000	250,000	275,000
United	743,527,683	733,590,668	521,748,413	15,562,335	15,396,114	17,096,000	4,995,000	30,205,000	35,202,000
Waco	12,047,000	14,660,000	2,160,068	106,000	120,681	114,131	75,000	none	106,000

• Not disclosed. [1] Year ended July 31, 1944.

and a total of $421 million in 1942.

In previous articles we have pointed out that one of the most promising factors in the aircraft industry outlook was the apparent endeavor of company officials to bring inventories under better control. Large cash resources and reserves can melt away almost over-night on the rocks of huge inventory losses.

Here is tangible evidence that, with 1944 inventories down $130,000,000 from those of 1943, the industry made a grand beginning last year in curbing its potential inventory liabilities.

Sales of the 17 companies jumped to $5,600,000,000, against $4,233,000,000 in 1943 and $3,300,000,000 in 1942. There were several cases, as our accompanying chart shows, where individual company sales last year fell below those of the preceding year. Cutbacks, retooling, and contract readjustments caused that situation.

Actually there is no yardstick by which 1944 dollar volume can be accurately compared with that of the preceding year because of the enormous price reductions and contract readjustments effected in 1944. Consolidated Vultee, for example, made voluntary cash refunds and price reductions of $131,500,000 in 1944. The price of Republic Aviation's P-47 Thunderbolt fighter was cut to $43,000 from an average of $54,490 in 1943 and $66,000 in 1942.

Net earnings of the group were $70,674,000, against $67,379,000 in 1943 and $81,590,000 in 1942. Renegotiation sliced off about $13,000,000 of the aggregate 1943 profits—but that will not happen to the 1944 results, since the various companies know pretty much what to expect in renegotiation and have already made liberal allowances.

The 1944 tax charges of these companies came to the amazing total of $343,738,000—more money than the industry took in before the war and more money than it can hope to receive for its products for the first several years after the war is over. In fact, the unpaid taxes on the collective balance sheets came pretty close to their aggregate cash holdings of $351,271,000.

Most promising aspect of the industry's financial picture is the way it is setting aside reserves for postwar contingencies and readjustments. Some $47,000,000 were added to reserves last year by 13 companies, against $21,000,000 by 12 organizations in 1943. This makes total reserves for the 13 concerns $156,000,000.

Survival, not profit-making, is the greatest objective of the industry. So the opportunity again this year to fortify reserves still further will be welcomed by aircraft shareholders.

One way in which Congress could give substantial relief to the industry would be to permit them to cash in a portion of their excess profits tax postwar bonds. Postwar refunds coming to 16 aircraft companies total more than $40,000,000. The use of this money to meet reconversion costs would be of great aid to aircraft producers.

Another way in which Congress could help would be to speed up the relief which companies are offered under the carry-back provisions of the tax law. As the law now stands, a company may carry the unused portion of its excess profits tax credit for 1945 and its net loss (should it have one) and apply them against income of the last two years and claim a tax refund. However, even though a company is fairly certain it will have a net loss this year, it must go ahead and pay—during this year—the full amount of its 1944 taxes.

The change many tax experts are advocating would allow the company to estimate its earnings for 1945, calculate the refund it would be entitled to, and then deduct the amount of the refund from current payments it is making on 1944 taxes. Thus the company would be able now to collect a refund it might not otherwise get for two or more years.

Most of the companies in the industry have negotiated V or VT loan agreements, which will make available funds aggregating more than $600,000,000 for financing war contracts and terminations. So far, however, the industry has made surprisingly little use of these credits. Bank debt of the companies surveyed amounted to only $55,000,000 at the end of 1944 against $164,000,000 the previous year.

Current assets declined to $1,305 millions last year from $2,098 millions in 1943, but current liabilities, too, were down. They stood at $1,031 million in 1944 compared with $1,281 million the previous year. Dividends paid totaled $26,949,000 for the group, a gain of $3,800,000 from the preceding year.

Six of the companies reported their unfilled orders in 1944 annual reports, showing aggregate backlogs of $5,285,000,000. Douglas led with a backlog of nearly $2,000,000,000, followed by Consolidated Vultee with $1,700,000,000, North American Aviation $845,000,000, Republic Aviation $600,000,000, Ryan Aeronautical $103,000,000, and Aviation Corp. $37,000,000.

It is interesting to note that when the defense program started in July of 1940 these same six companies had collective backlogs of $334,000,000, a great portion of which were made up of British and French orders. And then when Pearl Harbor came along, the unfilled orders of these companies had grown to $2,012,000,000.

For the first time, Douglas and Lockheed made mention of their postwar commercial transport orders. Pres. Donald Douglas revealed that his company had $129,000,000 in such orders on the books and was in the process of negotiating with airlines for another $129,000,000. Pres. Robert Gross of Lockheed pointed out that his company had $150,000,000 in commercial transport orders, making a grand total of over $400,000,000 for the two

(*Turn to page* 248)

17 AIRCRAFT MANUFACTURERS

Inventories			Earnings Per Share			Dividends			
1944	1943	1942	1944	1943	1942	1944	1943	1942	
$625,000	$388,000	$696,000	$1.31	$1.55	$1.31	$0.10	none	none	Aeronca
3,963,000	12,963,000	6,791,000	0.54	0.46	0.82	0.20	0.20	0.25	Aviation Corp.
20,094,000	13,183,000	21,331,000	6.76	5.54	5.93	1.00	1.00	1.00	Beech
2,839,000	7,988,000	15,459,000	1.57	3.15	2.11	0.40	1.00	1.00	Cessna
129,503,000	158,280,000	101,469,000	8.80	8.67	14.88	2.00	1.50	2.00	Consolidated
5,719,000	12,880,000	17,305,000	12.81	9.92	15.38	5.00	5.00	5.00	Douglas
22,018,000	24,016,000	3,435,000	9.53	6.58	2.63	1.50	1.50	1.50	Grumman
555,000	1,385,000	*	5.73	1.08	2.88	none	0.25	0.50	Interstate
46,892,000	50,620,000	38,657,000	4.20	7.42	7.59	2.00	2.00	2.00	Lockheed
52,903,000	95,166,000	121,297,000	4.37	2.68	6.01	3.00	3.00	1.50	Martin
59,593,000	74,868,000	42,235,000	2.44	1.98	2.15	1.25	1.00	1.00	North American
195,000	1,232,000	*	1.50	3.13	7.93	0.25	0.40	none	Northrop
1,383,000	1,485,000	1,287,000	0.27	0.36	0.76	0.12½	none	none	Piper
226,000	1,758,000	5,548,000	2.86	3.08	0.63	0.50	0.25	none	Republic
2,148,000	5,644,000	2,557,000	1.60	1.36	1.27	0.35	0.35	0.55	Ryan
64,372,000	68,854,000	53,559,000	5.37	5.30	5.95	3.00	3.00	3.00	United
412,000	447,000	*	0.73	0.83	0.79	0.30	0.30	0.30	Waco

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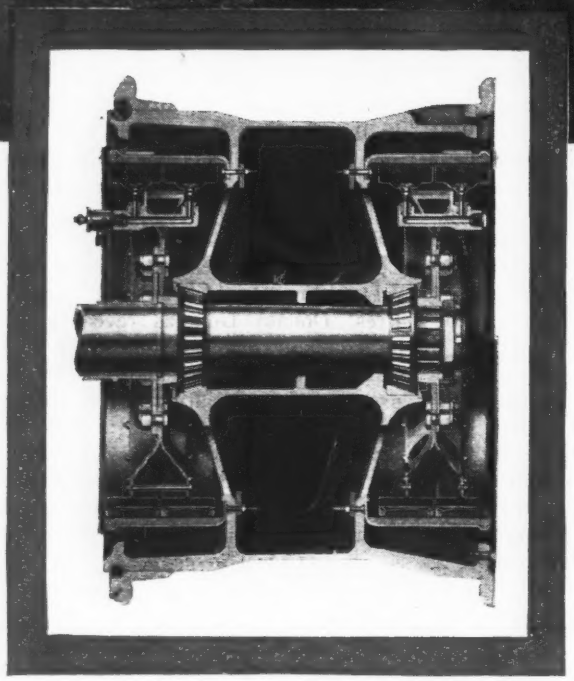

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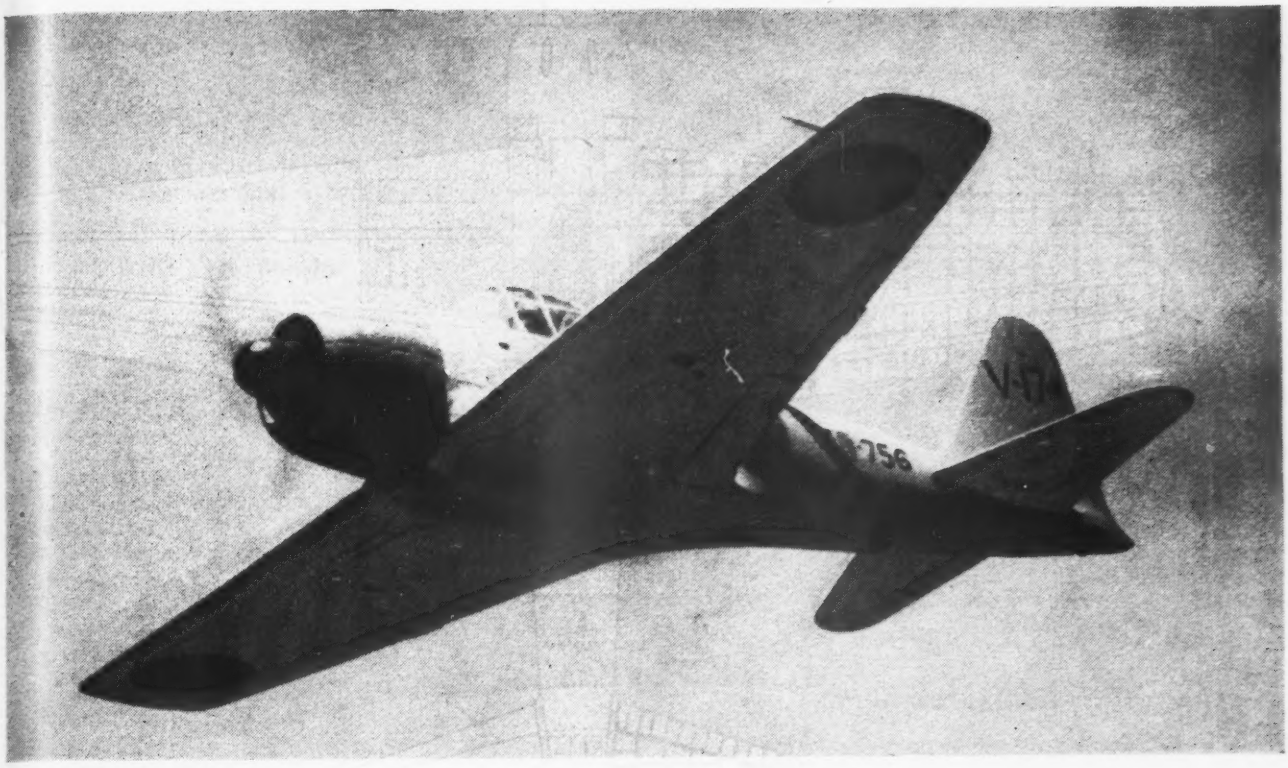


DESIGN ANALYSIS OF THE ZEKE 32 (HAMP)

Text by JOHN FOSTER, JR, *Managing Editor, "Aviation"*

Field sketches by CHESTER S. RICKER, *Detroit Editor "Aviation"*

Presenting the 12th of our series, a profusely illustrated part-by-part examination of the Zero's successor, showing how Jap engineers achieved unusually light structural weight without sacrificing strength.

LIGHT STRUCTURAL WEIGHT has been the prime consideration in designing the Hamp — now officially designated the Zeke 32— which was developed from the Jap's workhorse Zero fighter.

Nothing has been spared to keep weight down, neither excessive man-hours to manufacture complex units, nor increasing maintenance difficulties for ground crews. Lightening holes, for example, are used prolifically—even in the pilot's seat—and diameters as small as half an inch are found throughout the craft. Outstanding of the weight saving measures is complete elimination of protective armor and self-sealing fuel tanks. It all results in a plane that is extremely vulnerable despite good maneuverability at medium speeds.

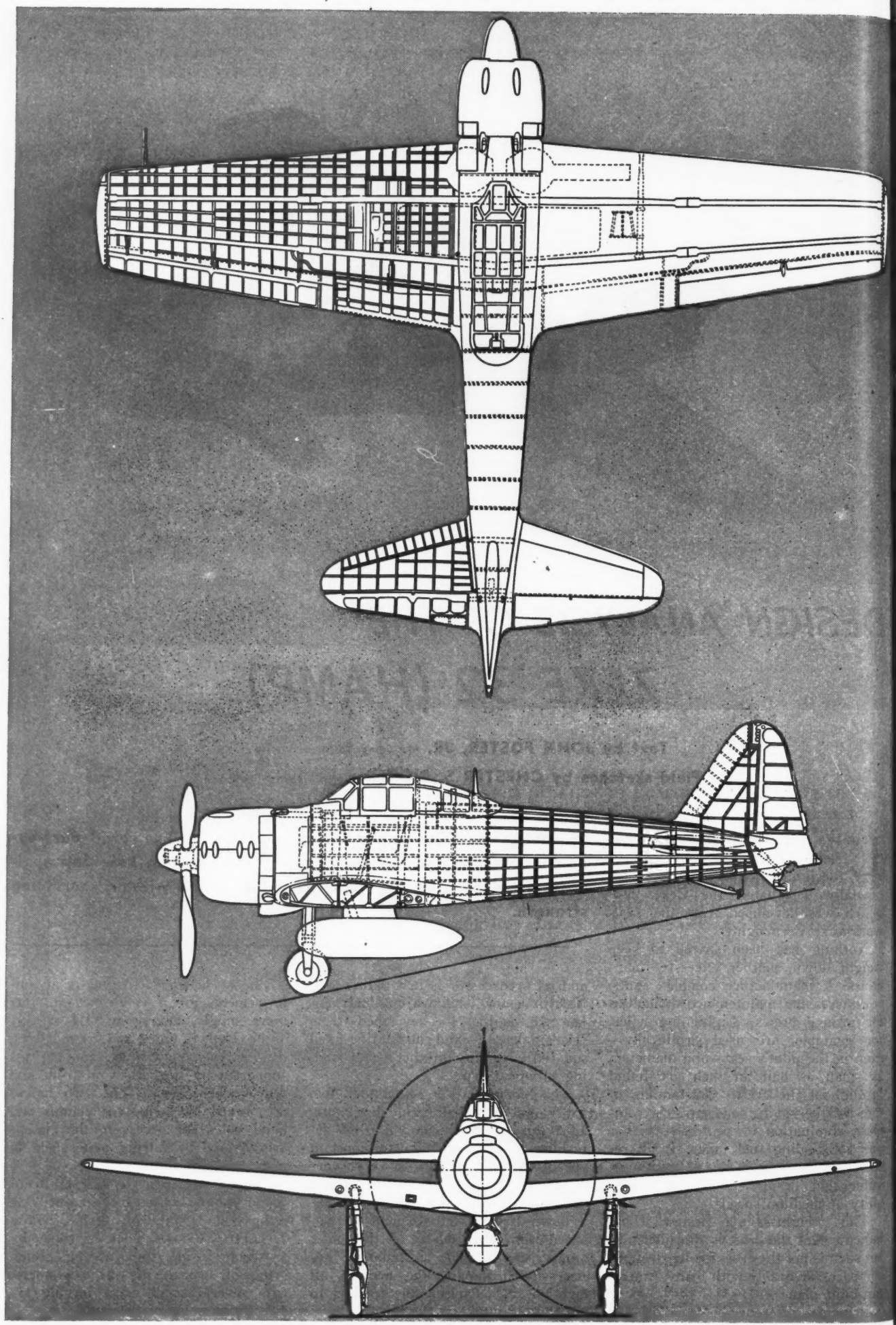
This weight-saving design would indicate that the craft is flimsily built, but such is not the case, for its strength compares favorably with many American-built planes.

Principal difference between Zeke 32 and its predecessor is installation of a Nakajima—or Ishikawajima-built Sakae 21 engine — developed from Zeke's Sakae 12—and substituting fixed squared wing tips for the earlier folding elliptical type.

The Sakae 21 is a 14-cylinder, two row radial aircooled engine developing 1,020 hp. at 2,600 rpm. at 6,400 ft., turning a 10 ft. 3-in. diameter constant speed propeller which is very, very similar to Hamilton Standard design. As installed in Zeke 32 the engine has a down-draft carburetor and a two-speed blower in place of the older single speed. The installation has necessitated moving the firewall aft eight in. and changing the cowling to put the air intake at the top.

The re-designed cowling is an improvement, for it is cleaner and fits more snugly, having an OD of only 45 in. Built in upper and lower halves, it is carried on channel section rings supported by steel links on front and rear rocker boxes. The two halves are joined by hook type clamps and hand holes for access to the clamps are covered by fairing plates held in place by quick fasteners.

Engine accessories are generally of sound design, but are not so sturdy as comparable American units whose design they follow. They are cooled by a scoop inside the cowling which brings air over the top of the cylinders, with several small ducts forcing air directly on some of the units.



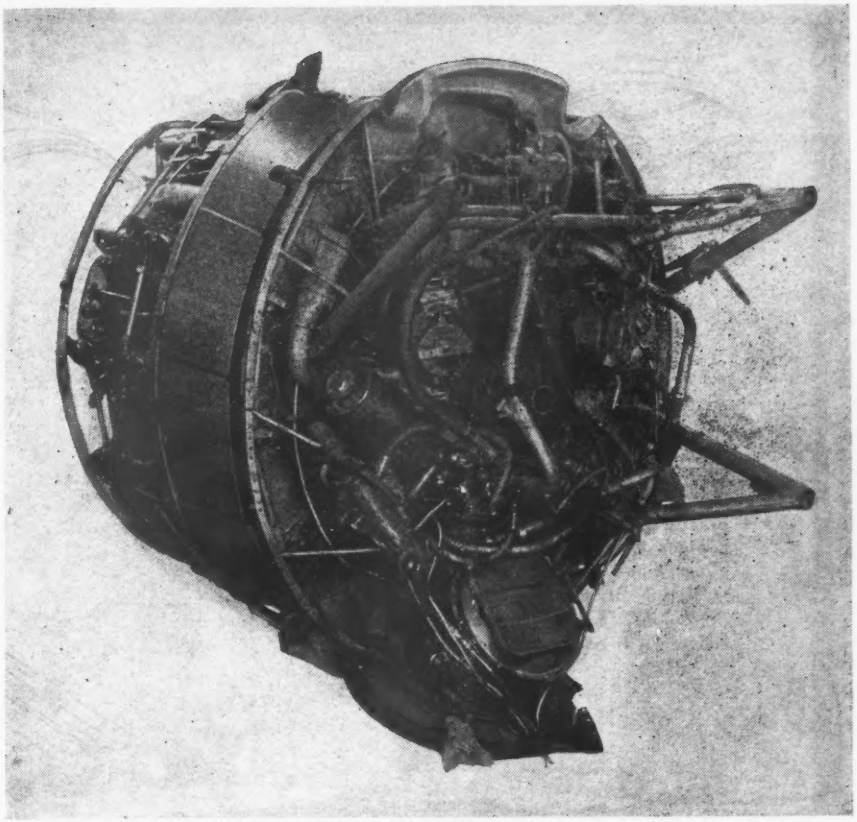
The engine is bolted to the 1⅜-in. diameter mount ring by 13 lugs welded to the ring. Of conventional tubular construction, the engine mount has side tubes of 1¼-in. diameter; top and bottom tubes of 1⅜-in. diameter, and attaches to the fuselage longerons by four high tensile bolts ⅝ in. in diameter and 1⅝ in. long.

前部胴體 Fore Fuselage

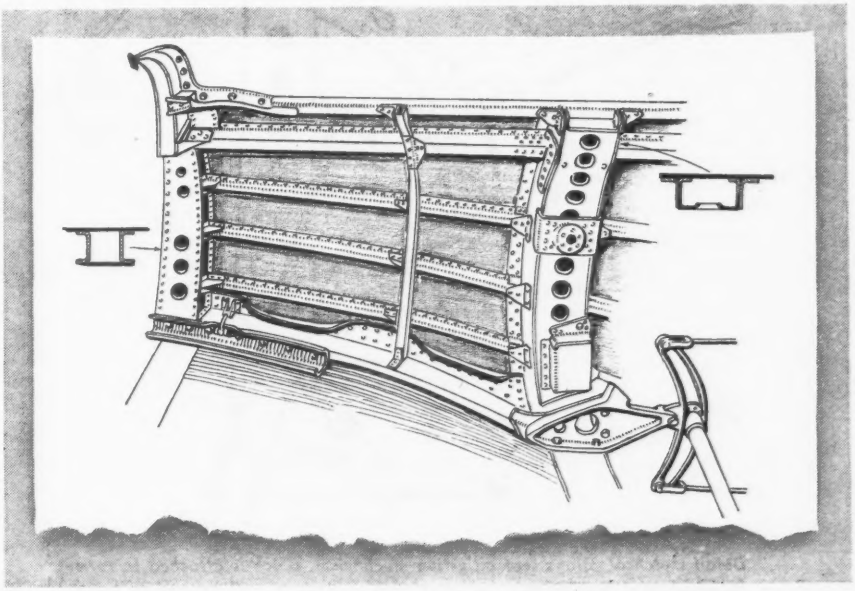
Hamp's fuselage is built in two sections, the semi-monocoque fore section extending from the firewall 103 in. aft to former J, which is just aft of the wing trailing edge and just forward of the aft end of the cockpit canopy fairing. This section is built integrally with the wing and, in fact, is not structurally complete until riveted to the top wing skin, which forms the cockpit floor.

Principal fore and aft members are four longerons, extending aft from the engine mount to former H, just forward of the wing trailing edge. The two top longerons are fairly heavy aluminum alloy hat-section members; the lower two are channel sections riveted to the upper wing skin and bolted to the spars. These longerons are flattened to accomodate formers B through H. Three ½-in. hat-shaped stringers are spaced evenly between the longerons and extend to former J.

Former A, to which is screwed the light sheet steel firewall, is a ring bulkhead containing the four engine mount bolts, while formers C and D shape skin around the fuselage fuel tank. Former D extends up from the front spar to the base of the windshield. Tapering to a width of 1½ in. at the top, it is made up of two channels with a box facing and has varying-sized flanged lightening holes. A heavy



Three-quarter rear view of 14-cyl. Nakajima Sakae 21 engine powering Zeke 32. Bore is 5.12 in.; stroke, 5.91; displacement, 1,700 cu. in., diameter, 45 in., length, 36 in., wt., approx. 1,175 lb. Cowl flaps are manually operated. (AAF photo)



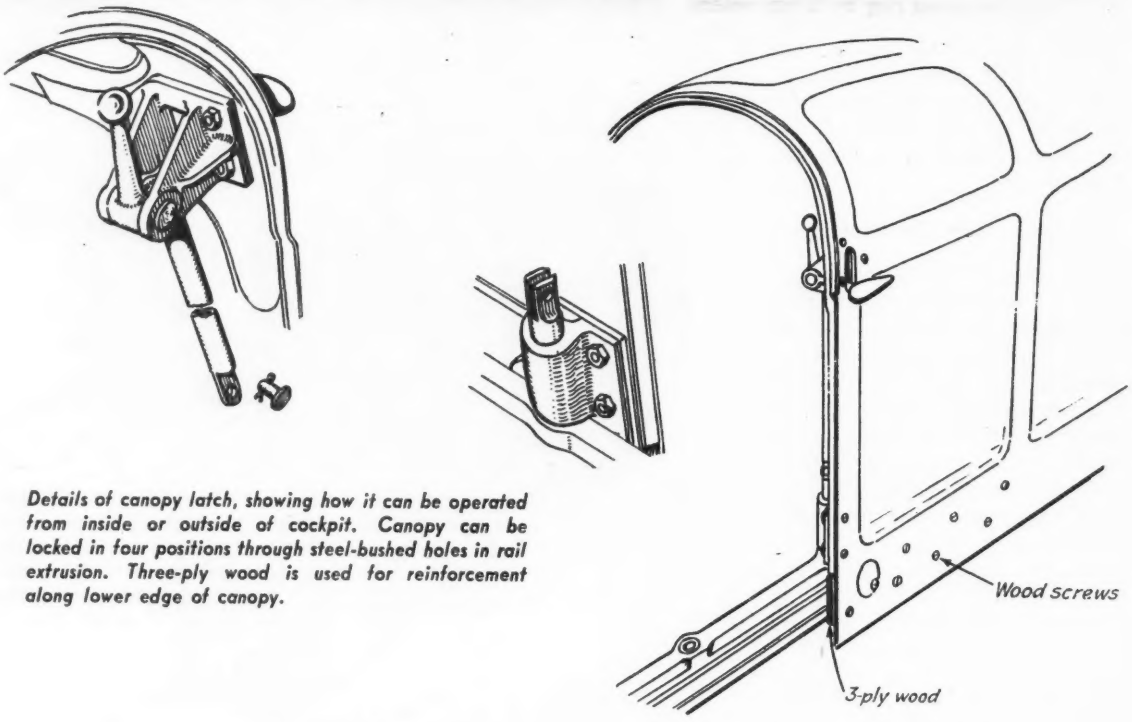
Right side of fuselage showing structure of formers D and G, built-up box structures mounted on front and rear spars respectively. Cockpit canopy rail extrusion forms top edge. Heavy longeron just below it extends from base of windshield to former J. Longeron at bottom of cockpit side follows contour of top wing skin which is cockpit floor. Brackets for elevator control are attached to former G and rear spar. Note that pivot pin is 1½ in. ahead of torque tube axis.

Specifications and Design Data

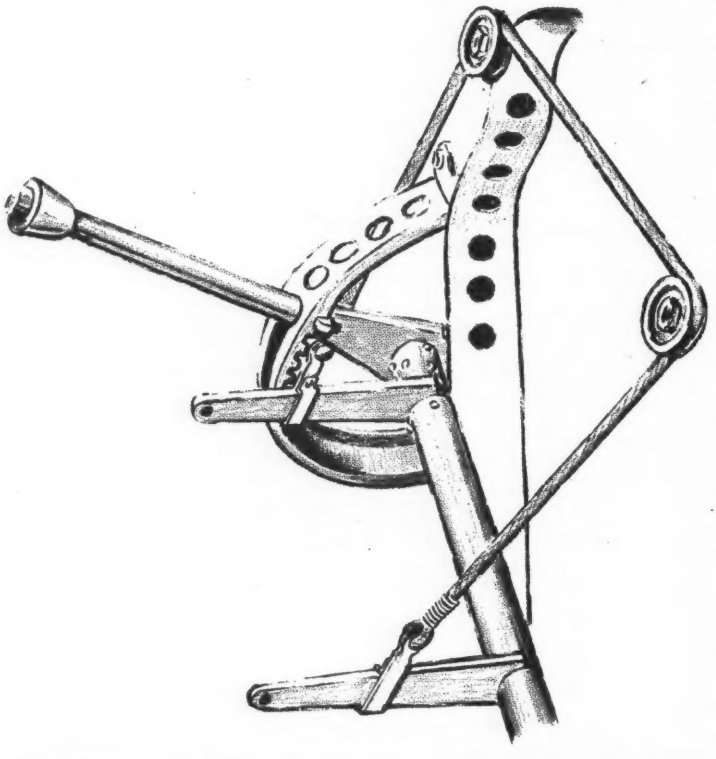
Span	36 ft. 2¼ in.
Length	29 ft. 9 in.
Height	9 ft. 2 in.
Gross wt., max. load	6,331 lb.
Gross wt., normal load	5,155 lb.
Wt. empty	3,913 lb.
Wing area	232 sq. ft.
CG	Approx. 31% MAC., 0.075 in. forward of main spar
Air foil (root)	NACA 2315
(tip)	NACA 3309
Max. chord thickness, center line	8¼ in.
Max. chord thickness, tip	4⅛ in.
Chord, centerline	8 ft. 3 in.
Chord, fuselage side (20 in. from centerline)	8 ft. 1 in.
Chord, tip	4 ft. 1¼ in.
Mean chord	6 ft. 4.8 in.
Aspect ratio	5.5
Dihedral, on 30% chord	6.5 deg.
Taper ratio	.44
Wing loading	21.3 lb/sq/ft
Power loading	5.42 lb/hp/sq/ft
Aileron area, total	20.2 sq. ft.
Aileron span, each	9 ft. 7⅝ in.
Flap area, total	16.44 sq. ft.
Flap span, each	5 ft. 3¾ in.
Horizontal tail area, total	51.68 sq. ft.
Stabilizer area, total	40.84
Airfoil, root	NACA-.0009-64 approx.)
Airfoil, tip	NACA-.0010
Span	15 ft. 5 in.
Mean chord	3 ft.
Aspect ratio	5.7
Taper ratio	.439
Elevator area, total	10.85 sq. ft.
Percent balance	11.35
Trim tab area	1.19 sq. ft.
Fin area	7.92 sq. ft.
Rudder height	4 ft. 6 in.
Rudder area	7.7 sq. ft.
Rudder area forward hinge line	0.7 sq. ft.
Rudder trim tab area	.065 sq. ft.
Percent balance	9.64

Performance

High speed	350 mph. at 17,000 ft.
Stalling speed, power off, wheels and flaps up	85 mph.
Stalling speed, power on, wheels down, flaps down 40 deg.	65 mph.
Stalling speed, power off, wheels down, flaps down 40 deg.	78 mph.



Details of canopy latch, showing how it can be operated from inside or outside of cockpit. Canopy can be locked in four positions through steel-bushed holes in rail extrusion. Three-ply wood is used for reinforcement along lower edge of canopy.



Detail sketch of pilot's seat adjusting mechanism, which is attached to former H. Shock cord bungee going up over pulleys tends to pull upward on bracket —on which seat itself is attached—as ratchet lever position is changed. Seat is adjustable only up and down; fore and aft adjustments are made on rudders.

tubular tie-through member at the top supports the two 7.7-mm. machine gun breeches and the top of the main instrument panel. A similar, but smaller diameter tubular tie-through member attaches to the bottom of the instrument panel and the middle of the three stringers.

Formers E and F are lightweight hat-shaped contour frames riveted to the longerons and stringers. Former G, a built-up hat-shaped structure, with lightening holes along the inner face extends up from the rear spar to the top longerons.

Former H, some 6½ in. aft, is a full contour built-up member extending from the lower longerons up through the fuselage top to form the turnover truss. Here again, lightening holes are much in evidence. Both fore and aft sides have some as large as four in. near the center, with another row of 1-in. diameter near the flange face which, in turn, has 1 in. holes spaced ½ in. apart. This member supports the pilot's seat via a torque tube to which two arms are riveted. The cutout in former H forms the only access to the accessory compartment, with entrance being gained by loosening two pins from the back support of the pilot's seat, and tilting it forward.

Former I is a light hat section frame. Former J is made up of 1 x ¾ x ⅛-in.

extruded angle sections with 80 holes for $\frac{3}{16}$-in. bolts spaced $1\frac{1}{2}$ in. apart forming a butt joint for joining to the aft fuselage section.

Fixed windshield consists of three flat plates of glass, none of which is bullet-proof. The cockpit canopy likewise uses ordinary glass, all flat plate except for the segments in the curved top, edges of which are beveled and rubber-mounted. The light aluminum-and-plywood frame slides 27 in. on six rollers in an extruded track section, and can be locked in four positions by a spring loaded pin sliding down into holes in the top of the track. Locking is accomplished either in or out of the cockpit by a handle set near the top of the forward part on the left side. No emergency jettisoning arrangement is provided.

座席房 Cockpit

In general the cockpit arrangement follows conventional practice except for size. While it's big enough for Japs, a typical American pilot in full flying gear would be pretty well jammed in. The top instrument panel includes the gunsight at the top, with the breeches of the two 7.7-mm. machine guns just below on either side, and the artificial horizon and bank and turn indicator centered. Also on this panel, mounted on Lord-type vibration absorbers, are the usual flight and engine instruments and switches. A panel on the pilot's left contains the throttle and gun quadrant; fuel tank selectors; hydraulic system controls; electric switchbox; etc. An unusual item on this panel is a parachute static line hook.

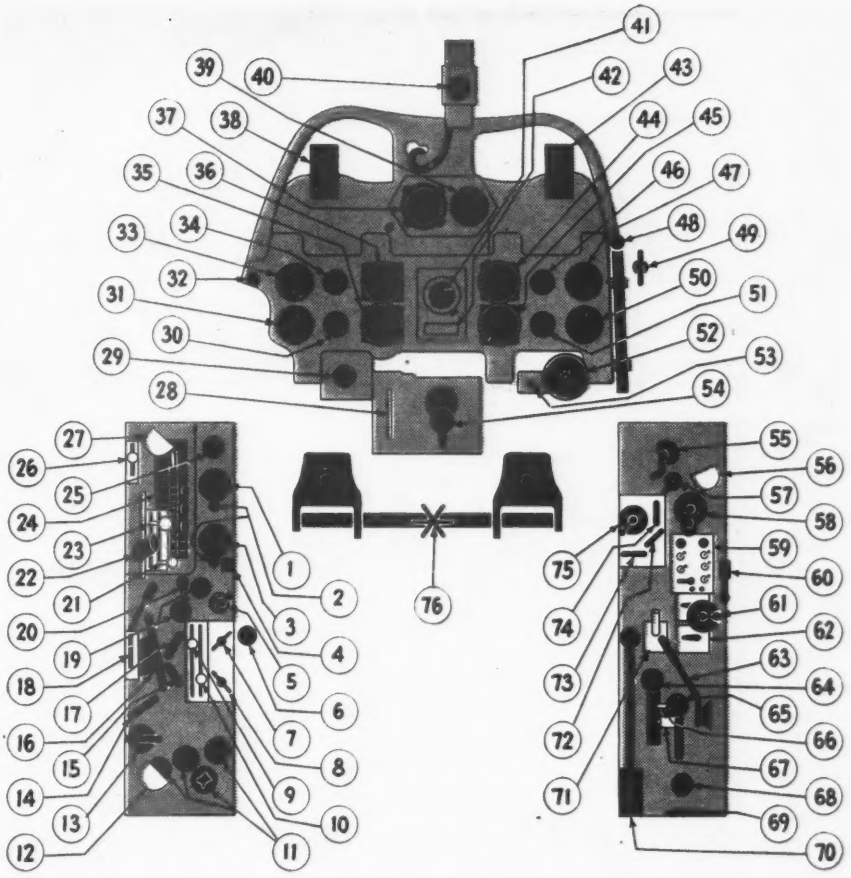
The panel on the right side contains mechanical cowl flap controls; radio controls; landing gear controls; arrestor hook release; fresh air tube; etc. Apparently cockpit heating equipment is not standard, but some planes have electric heaters around the air intake.

Also on this side is the lever for raising or lowering the pilot's seat which is adjustable only up and down. The lever has a push button like an automobile emergency brake, but no ratchet—merely a square tooth quadrant. A shock cord bungee passing over two pulleys on the turnover truss pull the supporting arms upward.

Entrance to the cockpit is from the left side, via three retracting steps and two hand grips, all of which are spring loaded and released by very smooth-fitting flush push buttons. One button releases the lower step—which drops down out of the fuselage just aft of the trailing edge—and one which comes out the fuselage side just above the wing. Individual buttons are used for the other steps and grips. The steps and handles behind the overturn bulkhead have $2\frac{1}{2}$-in. diam. .024 aluminum mushroom-shaped heads on the inside to prevent puncturing the fuselage flotation gear, which will be discussed in detail later.

Although these steps and grips must add considerably to the man-hours involved in production, they perhaps save weight which would be necessary if heavier skin were put on the wing. Too, they help maintain clean aerodynamic design and do not necessitate breaking up the finish, which is exceptionally smooth all over the plane.

Throughout the cockpit, wherever possible, brackets or supports are located between spanwise and lengthwise members so as to give a little additional strength.

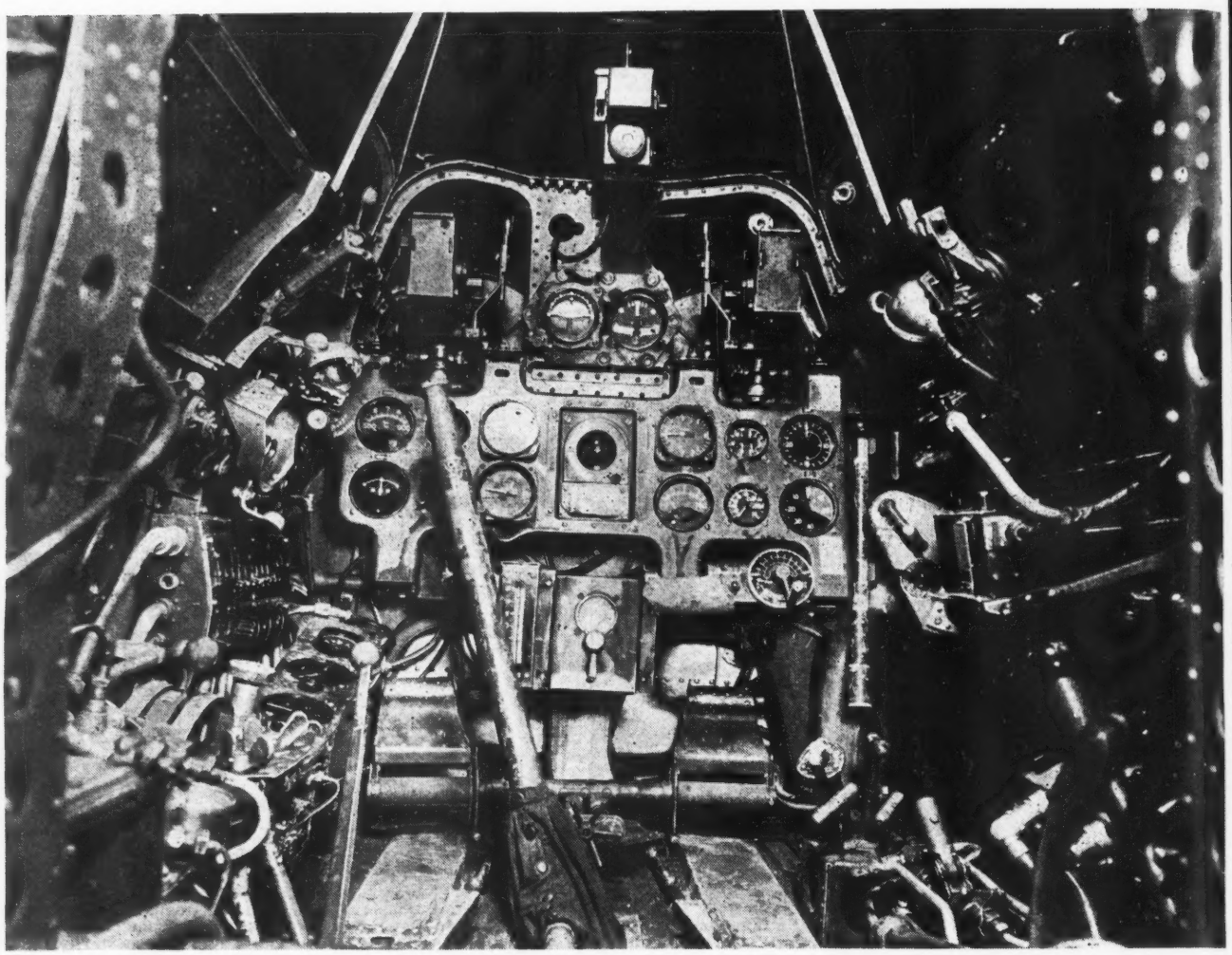


Diagrammatic layout of cockpit.

1. Fuselage tank gage.
2. Gage controls.
3. Wing tank gage.
4. Parachute static line hook.
5. Wing tank gage selector.
6. Wobble pump.
7. Fuselage & belly tank selector.
8. Wing tank selector valve.
9. Bomb release handle.
10. Tail wheel lock.
11. Pneumatic system controls. (out)
12. Cockpit light.
13. Flotation valve.
14. Fire extinguisher control.
15. Not used.
16. Trim tab control.
17. Belly tank release.
18. Gun safety.
19. Pneumatic system controls.
20. Gun charger.
21. Supercharger control.
22. Throttle & gun selector.
23. Automatic mixture control.
24. Electrical switchbox.
25. Free air temperature gage.
26. Manual mixture control.
27. Cockpit light.
28. Inclinometer.
29. Primer.
30. Magneto switch.
31. Radio compass indicator.
32. Emergency power booster.
33. Exhaust temperature gage.
34. Clock.
35. Altimeter.
36. Air speed indicator.
37. Artificial horizon.
38. 7.7 mm. machine gun.
39. Bank & turn indicator.
40. Gunsight.
41. Compass.
42. Compass correction card.
43. 7.7 mm. machine gun.
44. Rate of climb.
45. Cylinder head temperature.
46. Fuel & oil pressure gage.
47. Tachometer.
48. Hydraulic pump handle.
49. Carburetor air control.
50. Manifold pressure gage.
51. Oil temperature.
52. Oil shutter control.
53. Ignition booster switch.
54. Oxygen control.
55. Cowl flap control.
56. Cockpit light.
57. Band switch.
58. Frequency selector.
59. Radio.
60. Arrestor gear controls.
61. D/F Loop control.
62. Radio controls.
63. Arrestor gear hook release.
64. Landing gear selector.
65. Flap selector.
66. Safety lock.
67. Warning horn button.
68. Hydraulic pressure gage.
69. Warning horn.
70. Seat adjustment lever.
71. Emergency hydraulic control.
72. Right wheel up lock release.
73. Left wheel up lock release.
74. Cockpit air control.
75. Wing tank ventilator control.
76. Rudder bar adjustment.

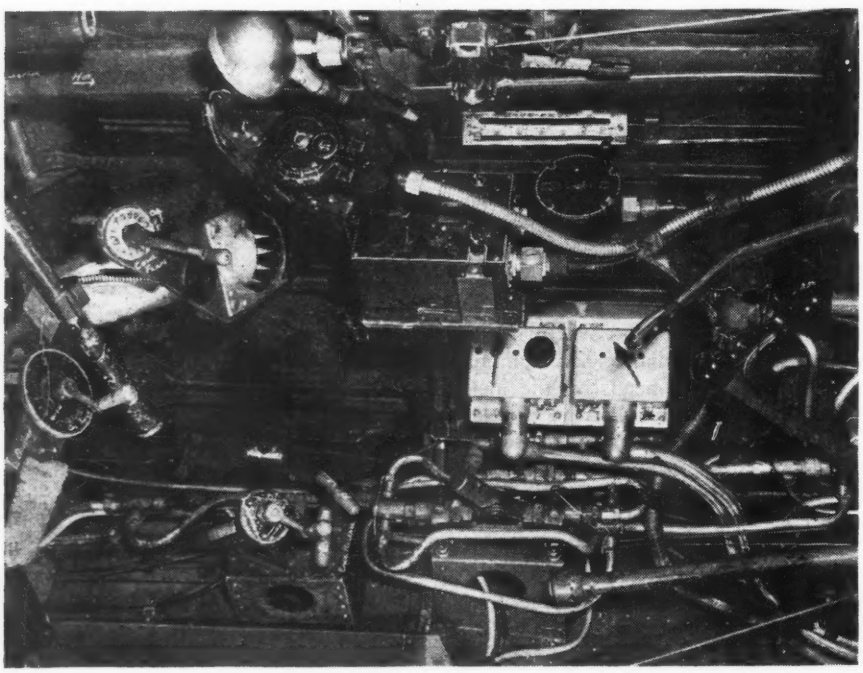
備品 Accessories

A compressed air cylinder; battery; DF radio receiver; hydraulic fluid reservoir; and oxygen cylinders are located aft of the pilot's seat between



View of cockpit with pilot's seat removed, showing former H, which forms turnover truss in foreground. Landing gear selector lever is shown at lower right. (AAF photo)

formers H and J. The oxygen cylinders can be re-charged from the outside by removing a flush-fitting plate held in place by a quick fastener to expose the connection and gage. In this section, too, brackets are arranged where possible to give some added strength.



Right side of cockpit showing, at left, oil shutter and cowl flap adjusting cranks with cockpit ventilating tube seen at end of cowl flap crank. (AAF photo)

後部胴體 Aft Fuselage

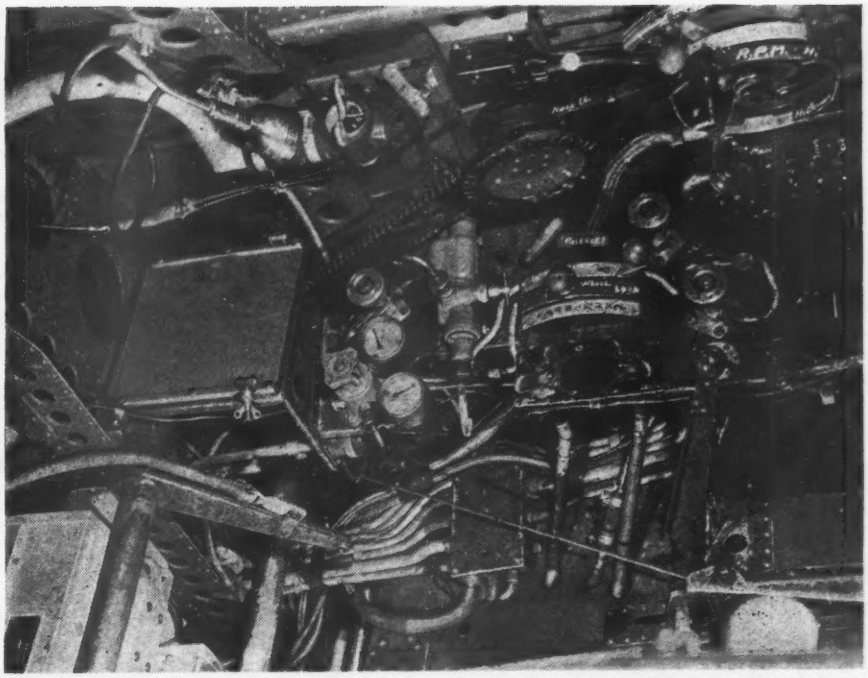
Aft section of the fuselage is full monocoque, extending from former K, which is butt-bolted to former J, but of lighter material, to former V, a distance of 144 in.

All except L and N are full circumference, spaced 16 in. apart, and are J section, and those near the front end are 1½ in. deep. These are built up in three sections, lap-jointed and riveted. Gages vary from .048 for the front lower sections, through .035 at the top, to .018 for those near the aft end.

All the formers have standard cutouts for the stringers, with ¾-in. lightening holes between stringers.

There are 22 Z-shaped ½-in. deep stringers in the aft fuselage section, spaced approximately 6 in. apart at the fore end. All have four right angle clips for attaching to the frames. A built-up hat-section longeron extends along the bottom from former K to aft of former S, where the arrestor

Left side of cockpit showing structure of turnover truss (extreme left), elevator trim tab control and throttle quadrant (center and top right) and end of electrical switchbox. (AAF photo)



gear hook attachment is made.

Formers S and U carry tubes for stabilizer spar attachments and elevator trim tab control equipment. Former V is built up of a channel section frame supporting the fin post, bottom rudder hinge and the tail wheel drag yoke fitting which is riveted to the bottom. This member is not parallel to the other formers, since the bottom is farther aft, putting it nearly vertical to the ground line when the craft is in three point position. Three stamped brackets on each side serve to anchor quick fasteners on the tail cone.

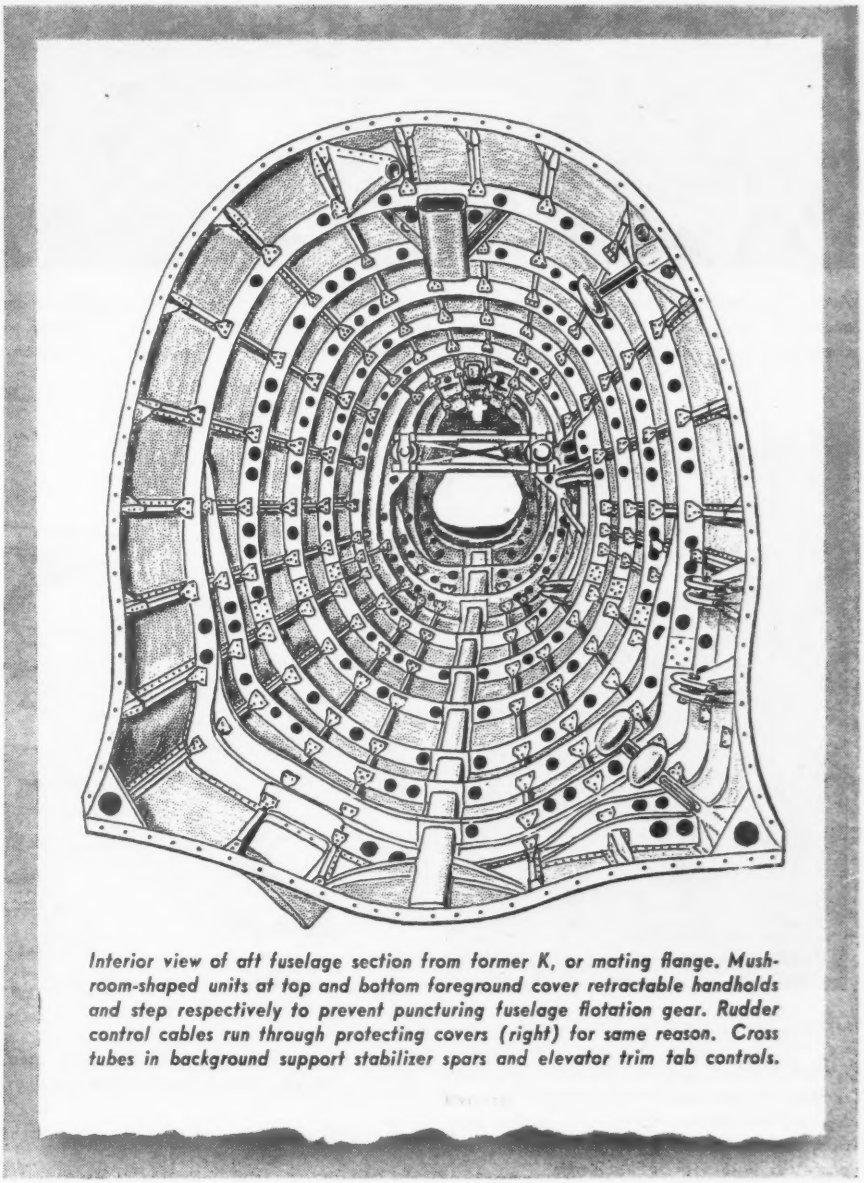
尾部覆 Tail Cone

This tail cone is comprised of two stamped alloy sheets with two J and two L-section stiffeners riveted inside each half. Small fairings extending out to the elevator also serve as stiffeners. It has a depth of 20 in. where it attaches to the fuselage; is 31¼ in. long at the top and 36 in. long at the bottom, where a formation light fits into the aft end. Three quick fasteners and ten screws on each side hold it in place, and a canvas dust catcher is screwed on and attached to the tail wheel drag yoke by a piano hinge. A bayonet plug connection is provided for the formation light. Removal of the tail cone exposes the tail wheel and combination retracting unit-oleo shock, and is one of the very few features of Hamp which would get any enthusiasm from a maintenance man.

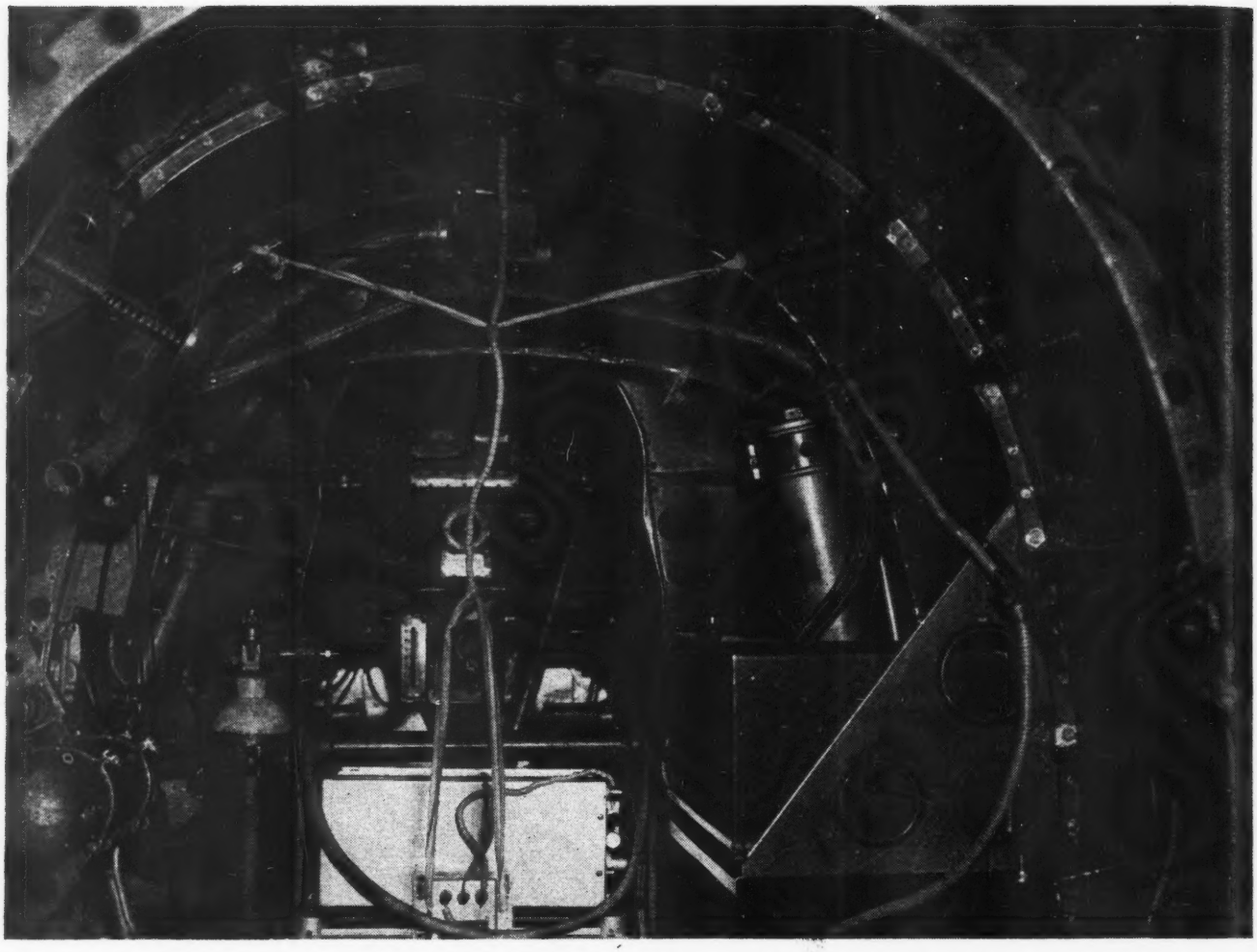
Skin on both fore and aft fuselage sections is of lighter alloy than is customarily used on occidental planes, that on the fore fuselage being .048 gage on the lower portion and .035 near the top, and .018 for all the aft section. It is flush riveted throughout, with all fore-and-aft joints being lapped, others butted. Also throughout Hamp, small rivets are used, few being larger than ⅛-in., some being only 3/32-in. Despite the rivet sizes, there is no evidence on the craft studied to indicate a lack of strength, nor were there any indications of sloppy workmanship.

翼浮舟 Flotation Gear

Hamp's main flotation gear for overwater operations consists simply of a large water-proof canvas bag in the aft fuselage section. This is connected to a tube leading to a barrel-type valve on the left side of the cockpit. Thus, when faced with a forced water landing, the pilot opens the valve, allowing

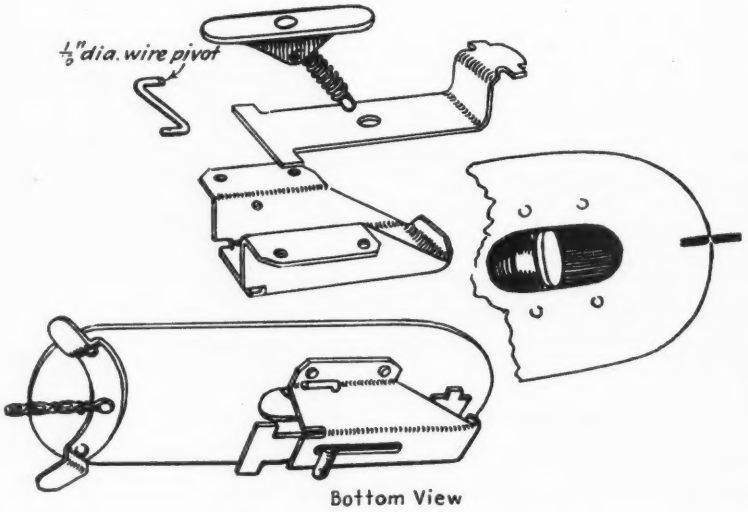


Interior view of aft fuselage section from former K, or mating flange. Mushroom-shaped units at top and bottom foreground cover retractable handholds and step respectively to prevent puncturing fuselage flotation gear. Rudder control cables run through protecting covers (right) for same reason. Cross tubes in background support stabilizer spars and elevator trim tab controls.



Accessory compartment inside fuselage just aft of turnover truss. Only access to this compartment is by tilting pilot's seat forward and crawling through opening in turnover truss. Note how brackets are set between spanwise and lengthwise members to give additional strength without increasing weight. Mushroom heads to protect flotation bag (shown in sketch on opposite page) are at upper left. (AAF photo)

Oxygen supply connection and pressure gage set in left side of fuselage just beneath retractable handhold. Cover plate is quickly removable but chained to prevent loss; red line on end assures replacing in proper position. Although of light construction, this plate fits flush with fuselage skin.



Detail sketch showing latches used to fasten cover plate to oxygen supply system. Hamp has very few openings, but majority are of this quick-opening type.

the bag to be inflated by pressure of the air rushing in through the intake, with the valve being closed when the bag is fully inflated. The main bag is not connected with the wing flotation gear, to be covered in the discussion of the wing.

The arrester gear, which appears to be left on the craft whether or not it is operating from a carrier, is built up of a T-extrusion with the forged hook riveted on. Extension and retraction is by means of a flexible cable running from a crank set in the right side of the cockpit. This handle incorporates its own lock, for the handle can be pivoted in toward the axle and locked into teeth extending out from the hub.

安定鈑 Stabilizer

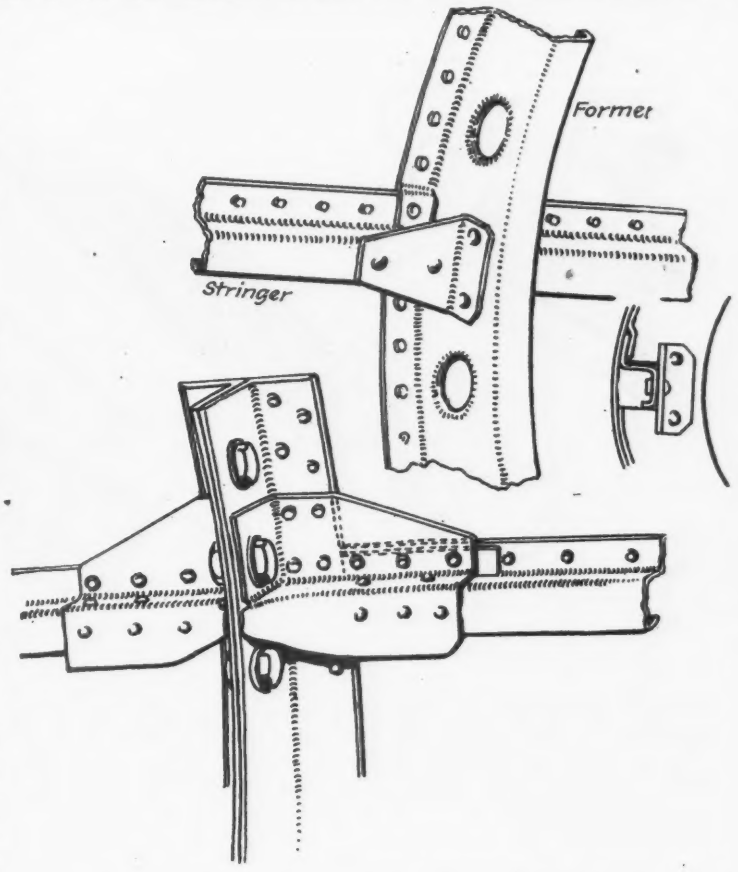
Stabilizer is two-spar full cantilever type, attaching to the tubes running through fuselage formers S and U by two shear taper pins on each spar. These tubes extend out $1\frac{7}{8}$ in. from the monocoque to the bolt centers, the gap being covered by a fillet extending back to the tail cone. Inboard stabilizer ribs are built-up truss type; the other seven are conventional stamped flanged aluminum alloy with lightening holes. Two spanwise channel stringers are used, one extending out to the tip, the other ending at the fifth rib. The leading edge has intercostals between each of the ribs. This section is attached to the front spar by top and bottom piano hinges.

The skin is all flush-riveted, the gage for the leading edge being .025; the remainder .018. Skin extends aft of the rear spar and both top and bottom surfaces are crimped to form hoods over the elevators.

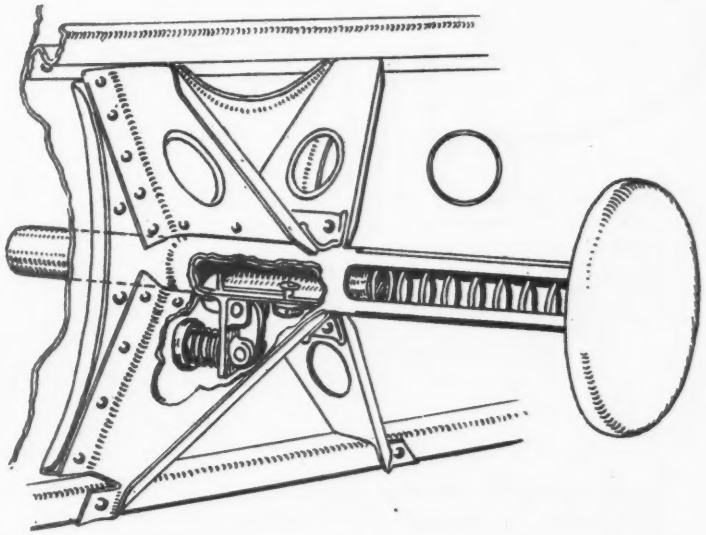
昇降舵 Elevators

Fabric-covered elevators follow conventional construction, with single spar and stamped flanged ribs having lightening holes $\frac{3}{4}$-in. apart. Fabric is sewed on in the old style, rather than being attached by metal clips or wire. The spar root forms a box into which the torque tube is riveted, this tube in turn being butt-bolted to a torque tube mounted in the aft fuselage with the mass balance attached to it. One craft examined had stop-cables attached to the horn, possibly to prevent green pilots from over-controlling. Elevators have three self-aligning ball bearing attachments for connection with the stabilizer.

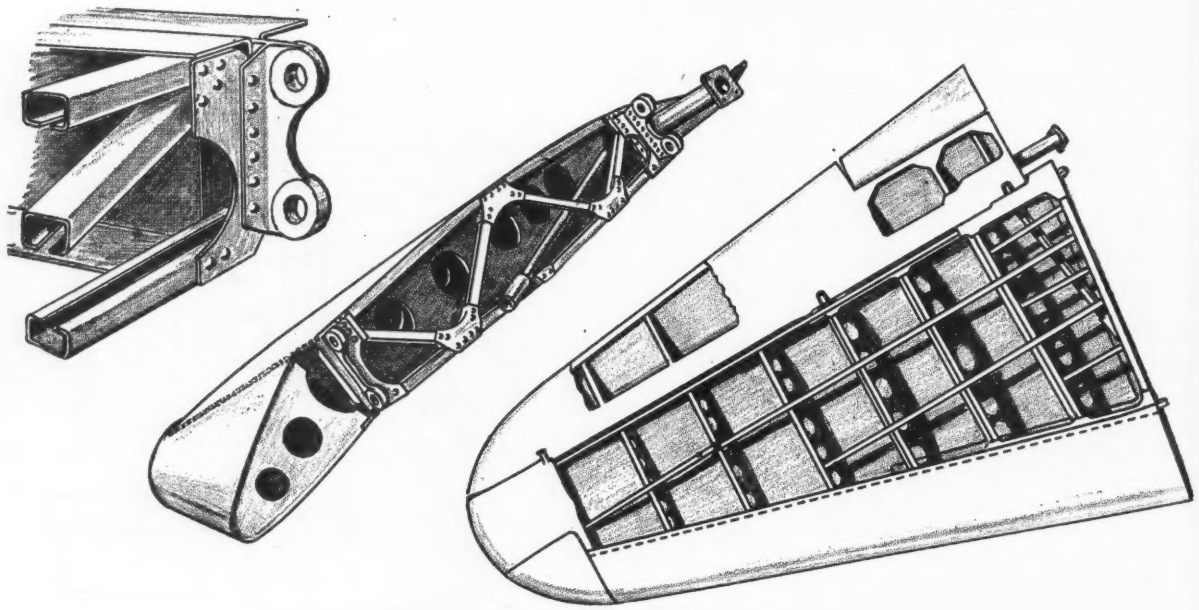
Elevators are the only control surfaces having trim tabs adjustable in the air. Operation of the tabs is by a vernier drum in the cockpit from which cables lead to a gear box mounted on former R. A short length of chain gives positive drive to the gears and a



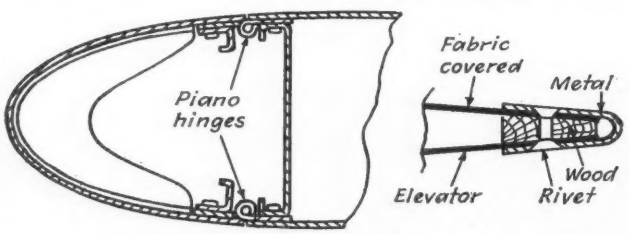
Method of securing J-section stringers to formers in aft fuselage section is shown at top, with sectional view shown in detail at right. Sketch at bottom shows typical arrangement of angle former K and stringer at former J (left) where aft section of fuselage is mated with fore section.



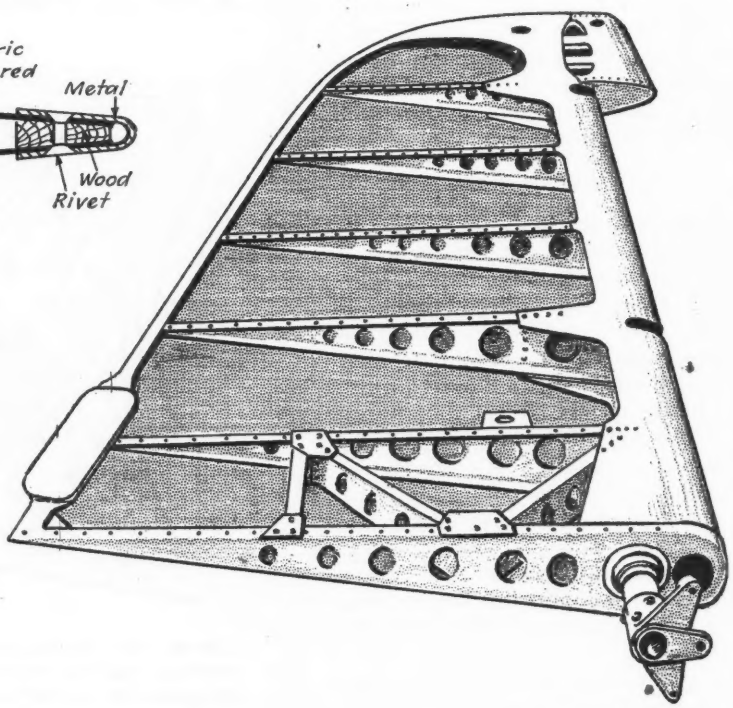
Cutaway view showing construction of upper handhold support bracket and mushroom head for protecting fuselage flotation gear. Tube handle is slotted and pushed out by small spring in skeleton tube, section of which is shown above tube. Button, flush with fuselage skin, releases latch which holds handle tube inside fuselage. A rivet projects in slot to prevent handle from flying off when released.



Stabilizer inboard rib and fuselage attaching fittings are shown in detail sketch (top left), with profile view (center) showing how leading edge of stabilizer is attached top and bottom by piano hinges. Elevator torque tube is shown just aft of rear spar. Plan view (right) with portion of skin removed, shows rib and stringer construction. Stabilizer trailing edge skin is crimped to form hoods over elevator leading edge, as is done on vertical fin.



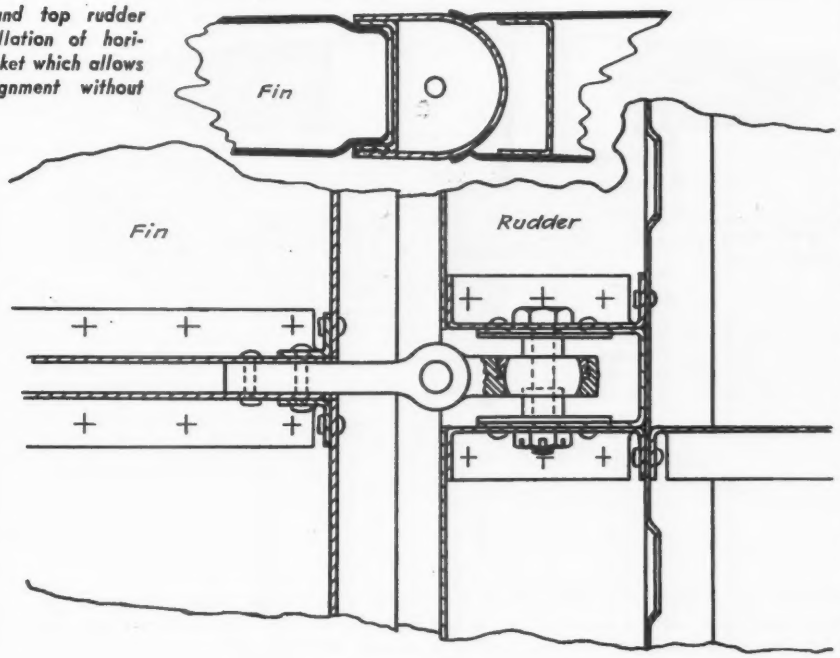
Cross section of stabilizer leading edge showing method of attachment to spar by piano hinge. Detail at right shows construction of trailing edge of elevator, illustrating use of wood for added stiffness with minimum weight.

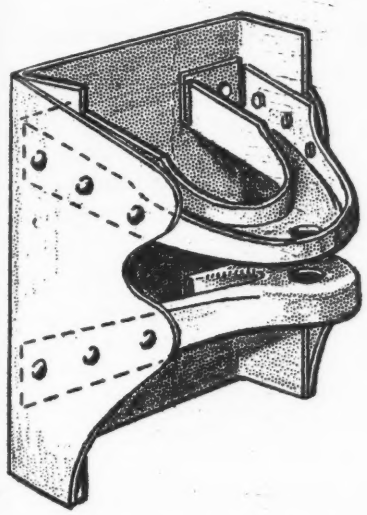


Rudder with one side of fabric covering removed to show rib construction. Control horn, with 5-in. spread, is welded to torque tube. Trim tab set in trailing edge is adjustable only on ground.

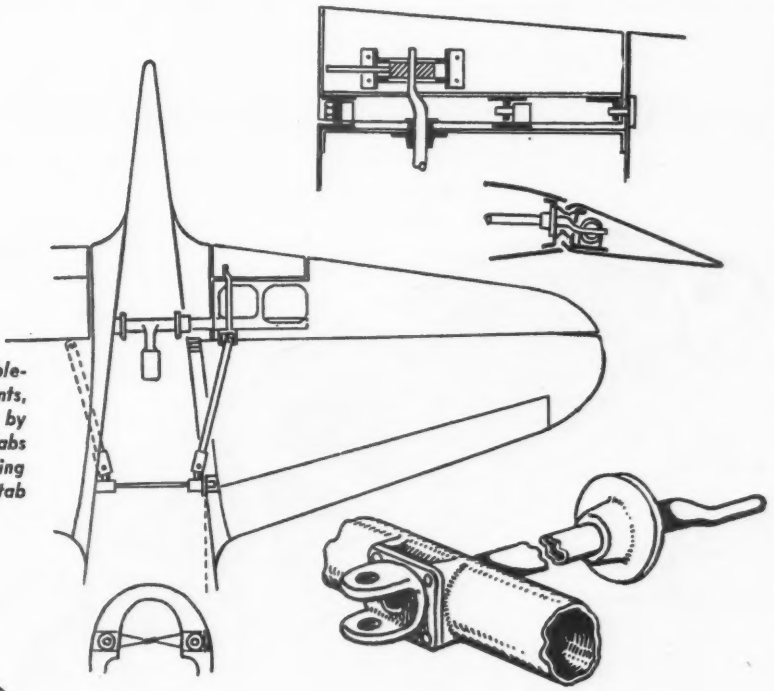
Top View Section

Details of middle and top rudder hinges, showing installation of horizontal pin-and-ball socket which allows some vertical misalignment without binding.

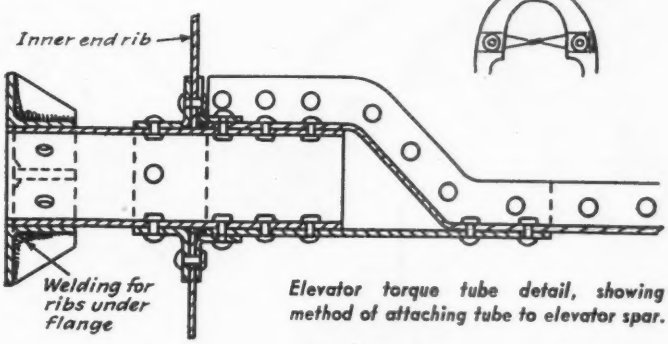




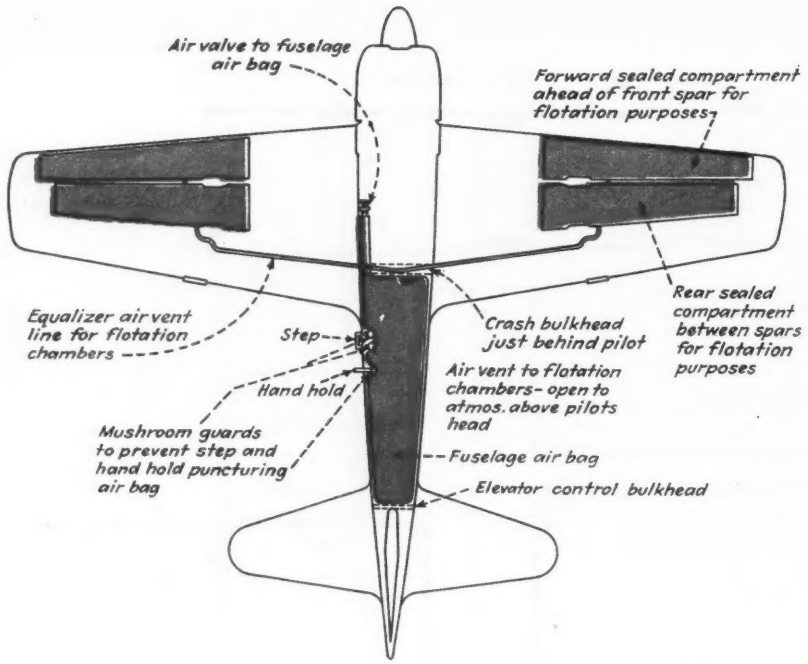
Bottom rudder hinge bracket showing typical use of formed thin metal built-up assemblies rather than forged or cast brackets.



Details of elevator trim tab controls, cable-operated from fuselage. Universal joints, shown in plan view, are interconnected by cable as shown in detail (lower left). Tabs are operated by small cranks engaging sliding bar encased in slotted tube attached to tab by angle brackets at each end.



Elevator torque tube detail, showing method of attaching tube to elevator spar.


Air valve to fuselage air bag
Forward sealed compartment ahead of front spar for flotation purposes
Equalizer air vent line for flotation chambers
Step
Hand hold
Mushroom guards to prevent step and hand hold puncturing air bag
Crash bulkhead just behind pilot
Air vent to flotation chambers- open to atmos. above pilots head
Rear sealed compartment between spars for flotation purposes
Fuselage air bag
Elevator control bulkhead

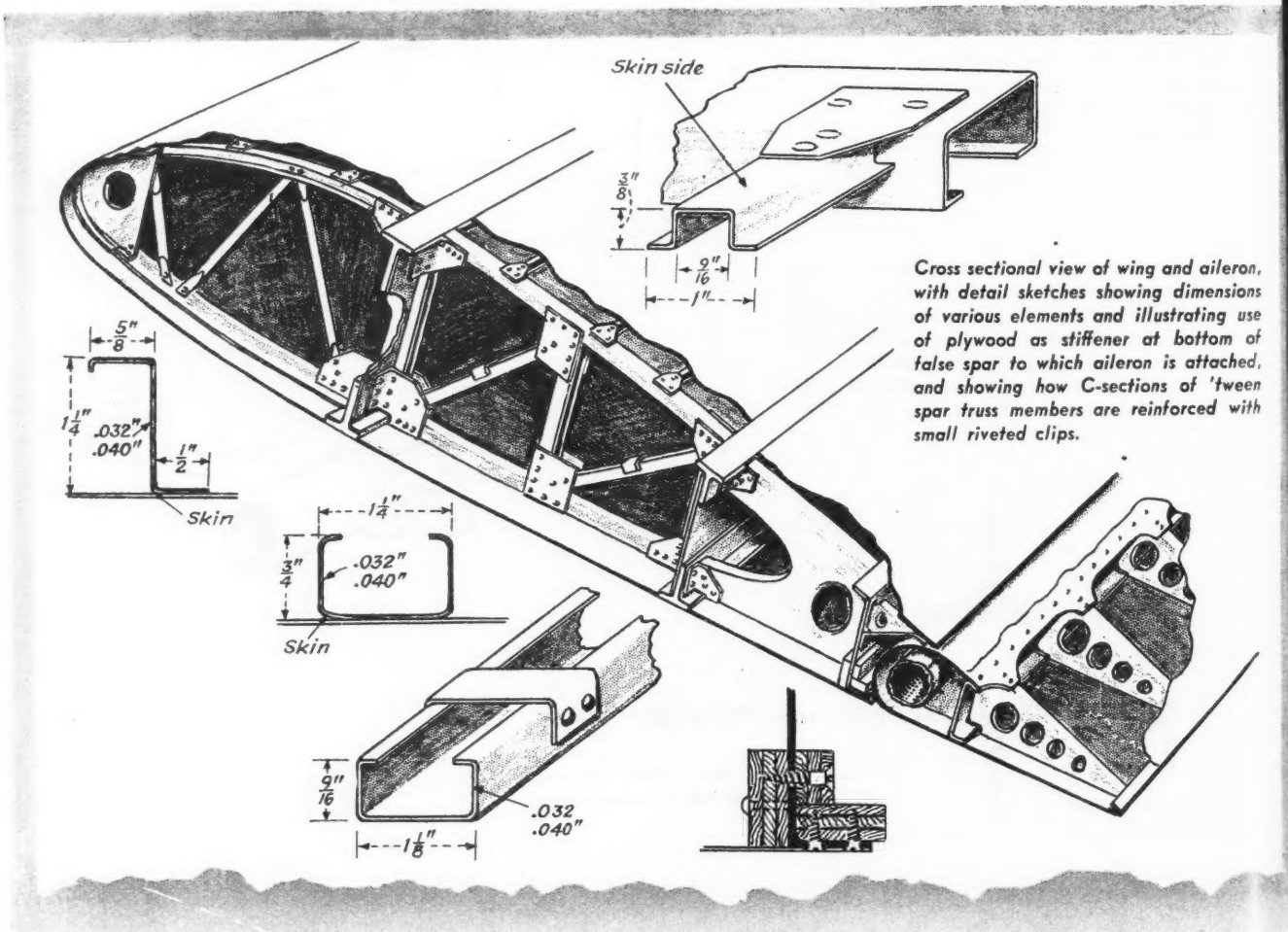
Diagrammatic layout of flotation gear. Wing gear is formed by making water-tight boxes, one formed by front spar, leading edge and ribs 8 and 23; other by front and rear spars and ribs 8 and 22. These are connected by tubes leading to cockpit with valve which can be closed in case of forced water landing. Fuselage gear consists simply of canvas bag with tube leading to valve in cockpit which can also be closed. Thus flotation gear consists simply of trapped air, valve arrangement being necessary to accommodate varying pressures due to altitude changes.

crossed cable drive carries motion to the right hand tab. Universal joints are installed just behind the gear boxes, with torque tubes from there to another pair of universal joints just ahead of the elevator torque tubes. A small crank turning in a slot in the tubular tab spar serves to change its angle.

It is quite possible that more than one Jap pilot has had trouble with his tabs, for no provision has been made to prevent fouling of the crossed cable turnbuckles, short little gadgets which apparently are necessary to keep the cables tight enough to give the necessary drive.

鯖及び方向舵 Fin and Rudder

The vertical fin is built integrally with the fuselage except for the 10-in. deep leading edge, which can be detached by removal of wires from piano hinges on either side. Backed by intercostals and ribs 5¼-in. apart, skin on the leading edge is .025 gage; that along the sides is .016 and, as is the case with the stabilizer, skin is carried aft of the rear spar and crimped on either side to form a horn over the rudder. Of two-spar construction the fin has four stamped, flanged horizontal ribs.



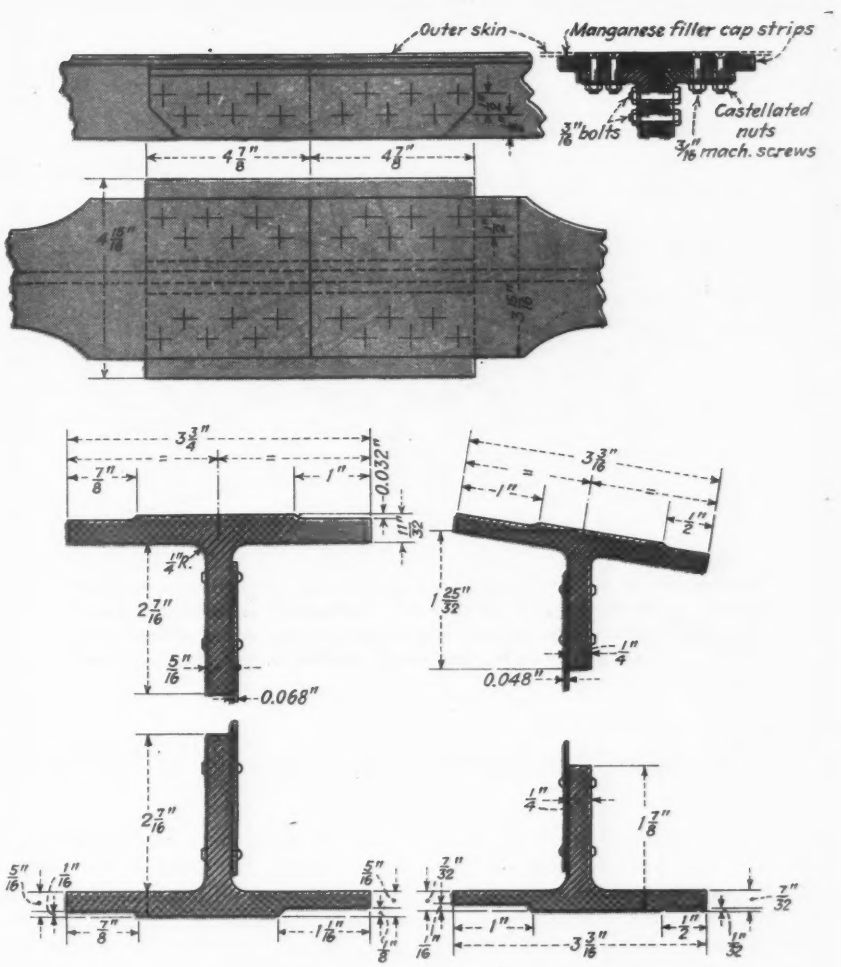
Cross sectional view of wing and aileron, with detail sketches showing dimensions of various elements and illustrating use of plywood as stiffener at bottom of false spar to which aileron is attached, and showing how C-sections of 'tween spar truss members are reinforced with small riveted clips.

Conventional design is followed in the fabric covered rudder, except that the small metal trim tab is adjustable only on the ground. The single spar is stamped, flanged and with lightening holes as are the ribs. Aerodynamic balance horn, of some 46 sq. in., is set at the top, fitting into a cutout in the fin. Three hinge points have self aligning ball bearings and the torque tube mounted on the bottom end is within the fuselage. The rudder horn has a 5-in. spread, and some Hamps have had wooden stop blocks installed in the hinge fitting at the horn. This installation, like the cables on the elevators, may possibly be to prevent green pilots from over controlling.

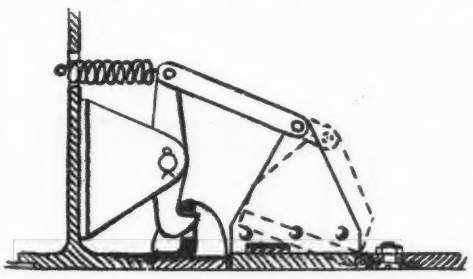
翼 Wing

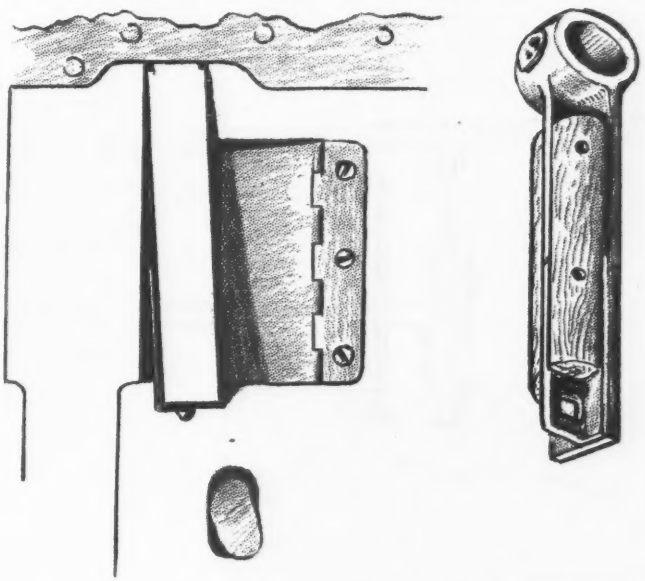
Hamp's full cantilever wing presents several unorthodox features, outstanding of which is the splice on each side between ribs 10 and 11. (There are 24 ribs from fuselage side to the tip.) Since no design or production advantages are gained, use of the splices may be necessary either to limited length of extrusions available, or to limited milling bed lengths. With these splices, both front and rear spars are continuous from tip to tip, like those on the Focke-Wulf 190 (analyzed in AVIATION for October, 1944) so that if either side is damaged, the entire wing—together with integral fore fuselage section—must be replaced.

Spars are constant tapering I-beams, built up of extruded T-sections and solid 16-gage web reinforced every 8 in. by seven hat section and 17 L-section stiffeners on each side. The ex-

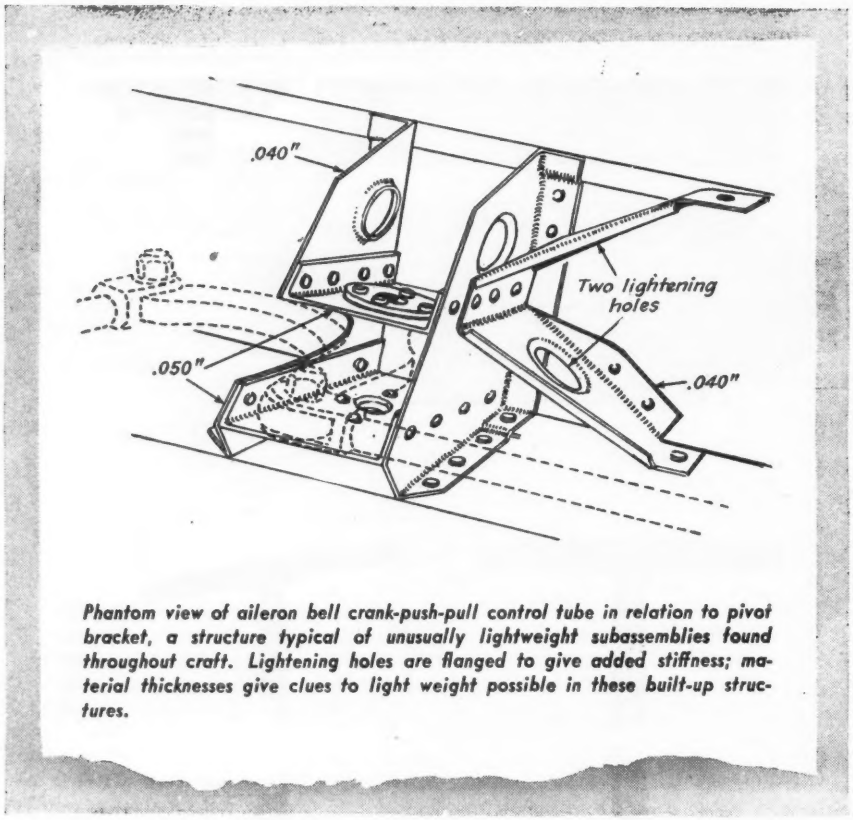


Plan view and cross section of spar splices—between ribs 10 and 11 on each side—and cross sections with dimensions of front and rear spars. Flanges of both top and bottom extrusions are milled out to depth of flush-riveted skin so that spars themselves form part of both upper and lower wing surfaces.





Flush-retracting handhold attached to front spar at wingtip. View from below (center) shows thumb latch which unlocks plate (shown attached by piano hinge) which, when pushed upward, releases latch and allows handle to be pulled down into vertical position. Cross section sketch (above) shows operation of plate and latch; that at right shows construction of grip itself.



Phantom view of aileron bell crank-push-pull control tube in relation to pivot bracket, a structure typical of unusually lightweight subassemblies found throughout craft. Lightening holes are flanged to give added stiffness; material thicknesses give clues to light weight possible in these built-up structures.

trusions are milled on the outer surfaces to the depth of wing skin, so that the spars themselves form part of the upper and lower wing surfaces.

Front spar is located at 32 percent of root chord and 27 percent of tip chord throughout the span, and the rear spar is at 65 percent of root chord and 64 of tip chord. Distance of spar centers on centerline of fuselage is 2 ft. 10¼ in., at tips it is 1 ft. 5¾ in.

Neither upper nor lower surfaces between spars and ahead of the front spar appear to enter beam bending strength, since all hat-section spanwise stiffeners spaced 6½ in. apart in these locations are intercostals, tieing only to ribs through flat skin reinforcements.

Open truss type ribs, spaced 8 in. apart, are used in the leading edge except ribs 4 to 7 for landing gear attachment, and 7 and 8 between which are located the 20-mm. Oerliken cannon. Upper and lower chord sections are J-section joined at the leading edge by formed plates. Webs are ⅜-in. OD tubing, flattened at the ends to attach to the J-sections. Holes are drilled in the upper ends of the tubes to prevent cracking by flattening.

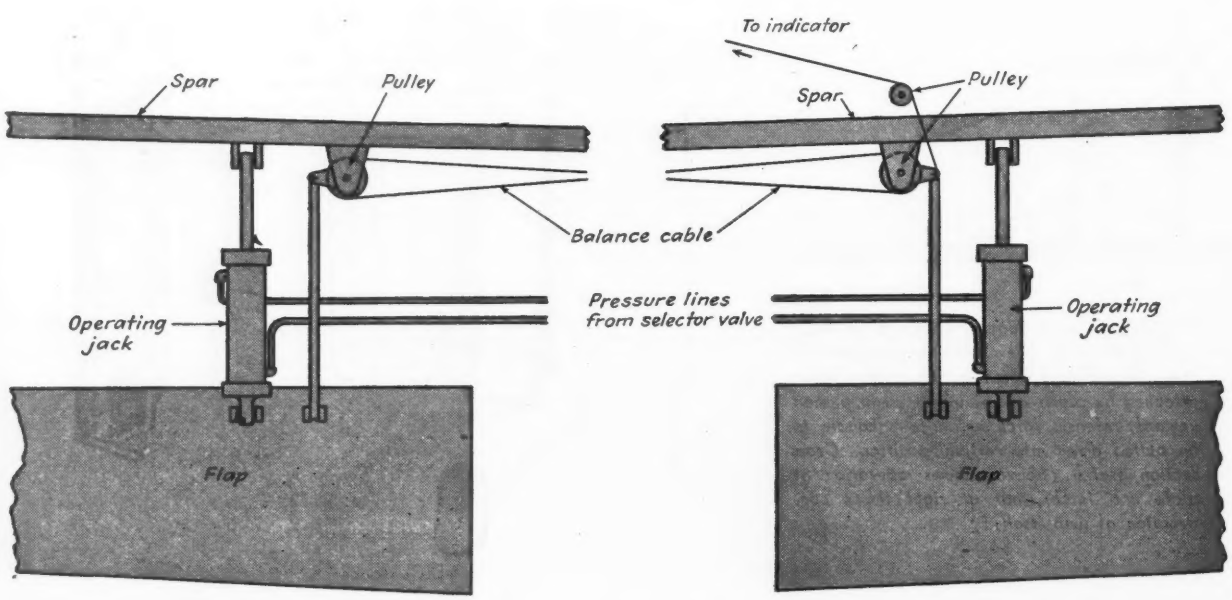
Nose ribs at the landing gear attaching point and on either side of the cannon are built-up box truss type—very complex units made of many small parts.

'Tween spar open truss type ribs are also spaced every 8-in. Every third rib is a compression member with formed C-section webs using double flanged gussets at all joints. Remaining ribs, although of similar truss type, are much lighter and are without gussets. Many of the C-sections in these ribs have clips at the mid-column point to tie the outstanding legs together and prevent collapse.

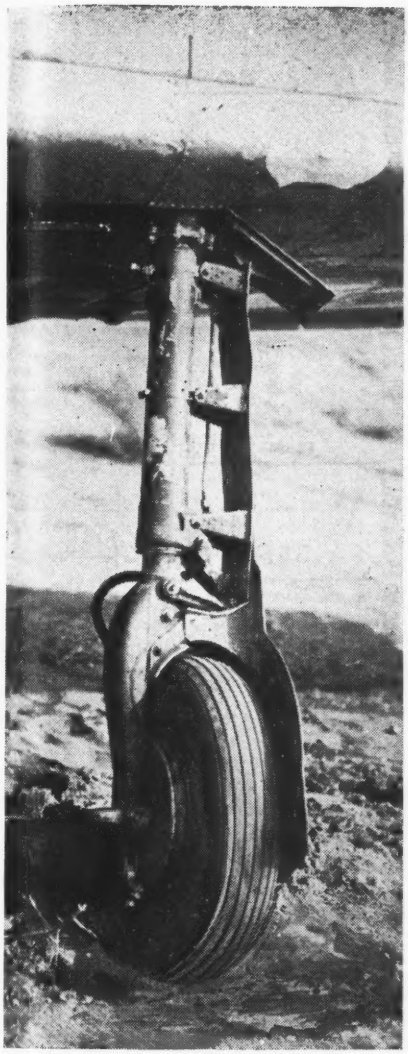
Additional flotation gear is built into Hamp's wing through two airtight compartments formed by sealing off two boxes, one formed by the front and rear spar and ribs 8 and 22, the other formed by the front spar, leading edge and ribs 8 and 23.

Trailing edge ribs extending from the rear spar to a false spar supporting flaps and ailerons are conventional stamped, flanged aluminum alloy with lightening holes. Stiffening the Z-section false spar without greatly increasing weight is achieved by screwing small strips of 3-plywood to both the inside face and along the flange of the lower edge.

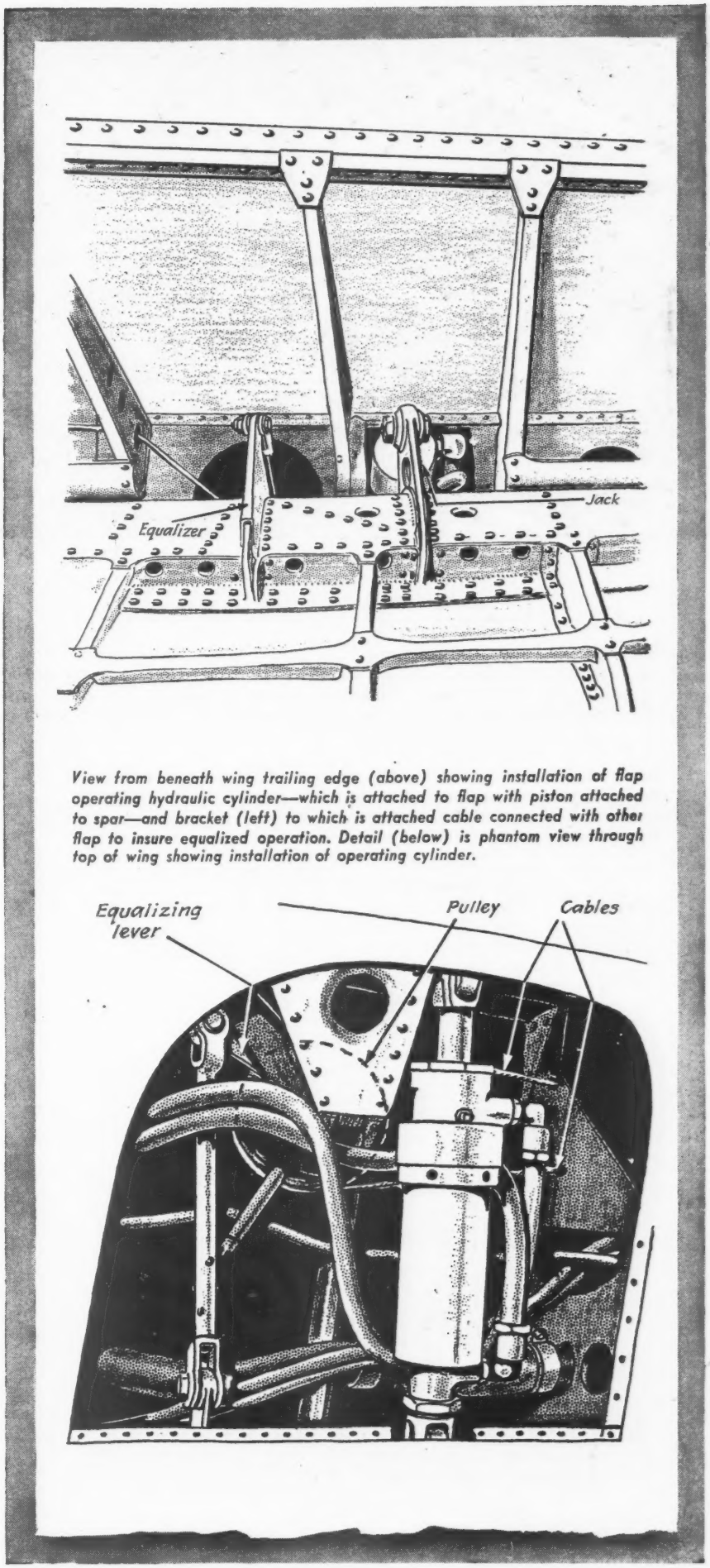
Surfaces of the wing, like those on the fuselage, are very smooth. Skin panels ahead of the front spar appear unnecessarily small, but those between spars are of normal size. Leading



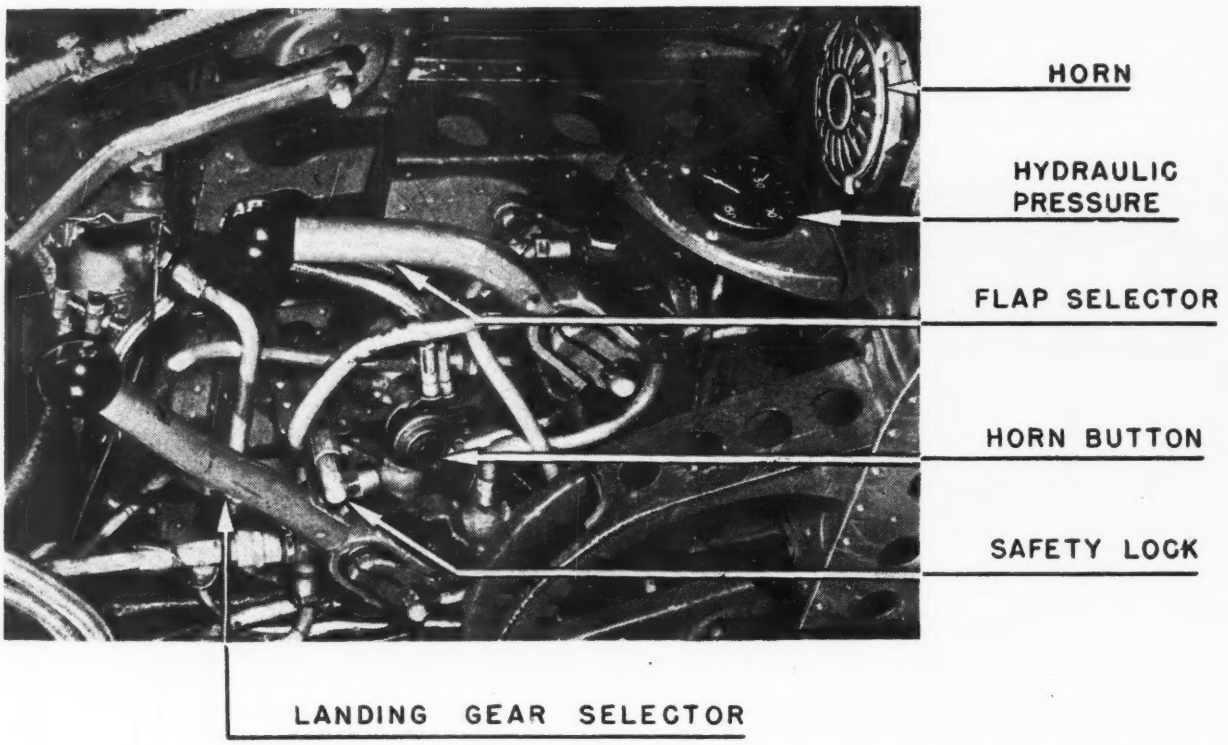
Diagrammatic layout of flap operating system, including interconnecting cables to provide equal action. Light cable from right flap runs to position indicator in cockpit.



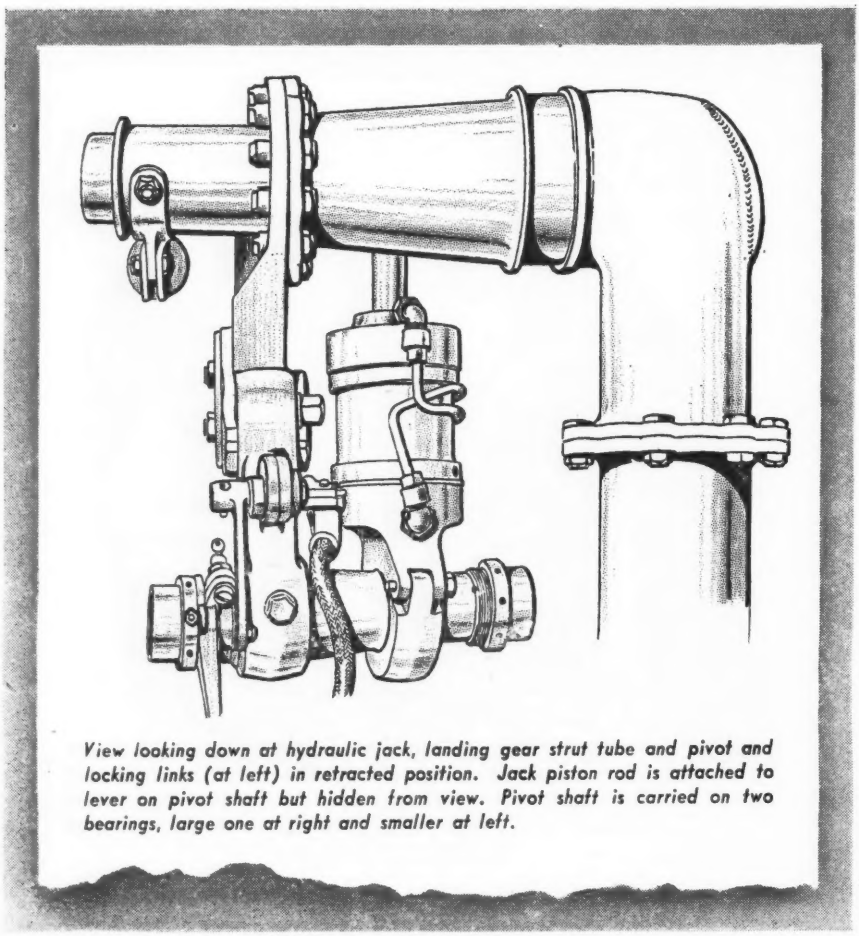
Left leg of main landing gear. Wheel fork is built up of welded steel stamping; legs are conventional steel forgings, 3½ in. in diam. with 3-in. oleos having 3½ in. stroke operating under about 230 psi. Wheel and tire together weigh but 28 lb. Close-up of wheel (below) shows uplock latch extending inward from axle and small ball and swivel which closes fairing to completely cover wheel in retracted position. (Ricker photos)



View from beneath wing trailing edge (above) showing installation of flap operating hydraulic cylinder—which is attached to flap with piston attached to spar—and bracket (left) to which is attached cable connected with other flap to insure equalized operation. Detail (below) is phantom view through top of wing showing installation of operating cylinder.



Landing gear operating control, showing safety lock pin. Attached to right wheel so that when craft is on ground and oleo is shortened by weight, this pin is forced out behind gear selector so that it cannot be moved and landing gear retracted. Warning horn blows if pilot does not return selector to neutral position after wheels have been retracted and locked but doesn't blow if he forgets to lower wheels when coming in for landing. Teeth on quadrant for vertical adjustment of pilot's seat are seen in lower foreground. (AAF photo)



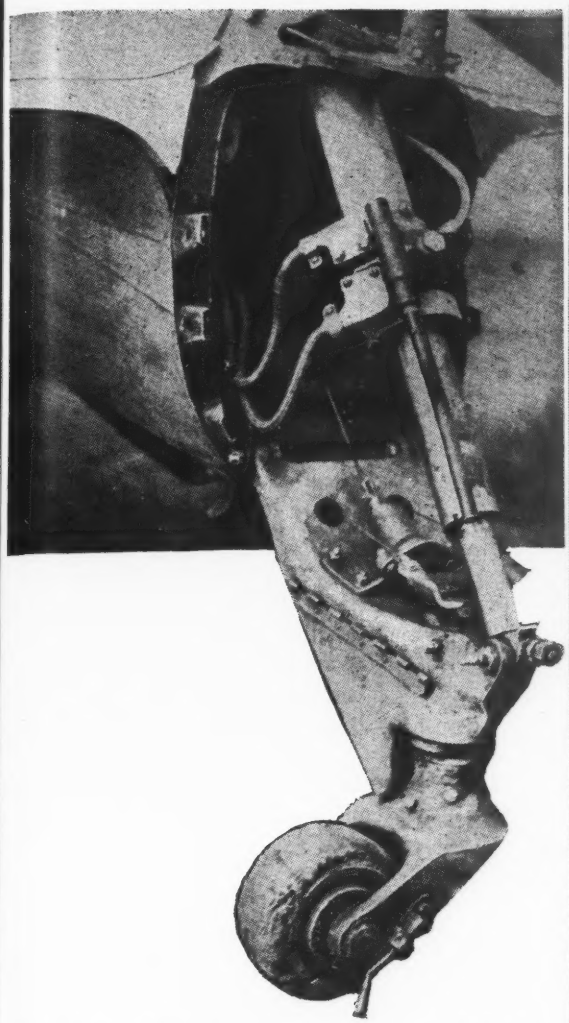
View looking down at hydraulic jack, landing gear strut tube and pivot and locking links (at left) in retracted position. Jack piston rod is attached to lever on pivot shaft but hidden from view. Pivot shaft is carried on two bearings, large one at right and smaller at left.

edge skin gage is .028; top surface between spars out to the cannon between ribs 7 and 8 is .035; from there to the tip, .027; lower surface between spars is .024; and aft of the rear spar is .022. On the wing too, very small flush rivets are used, most of them being $\frac{1}{16}$-in., but some are as small as $\frac{1}{32}$-in.

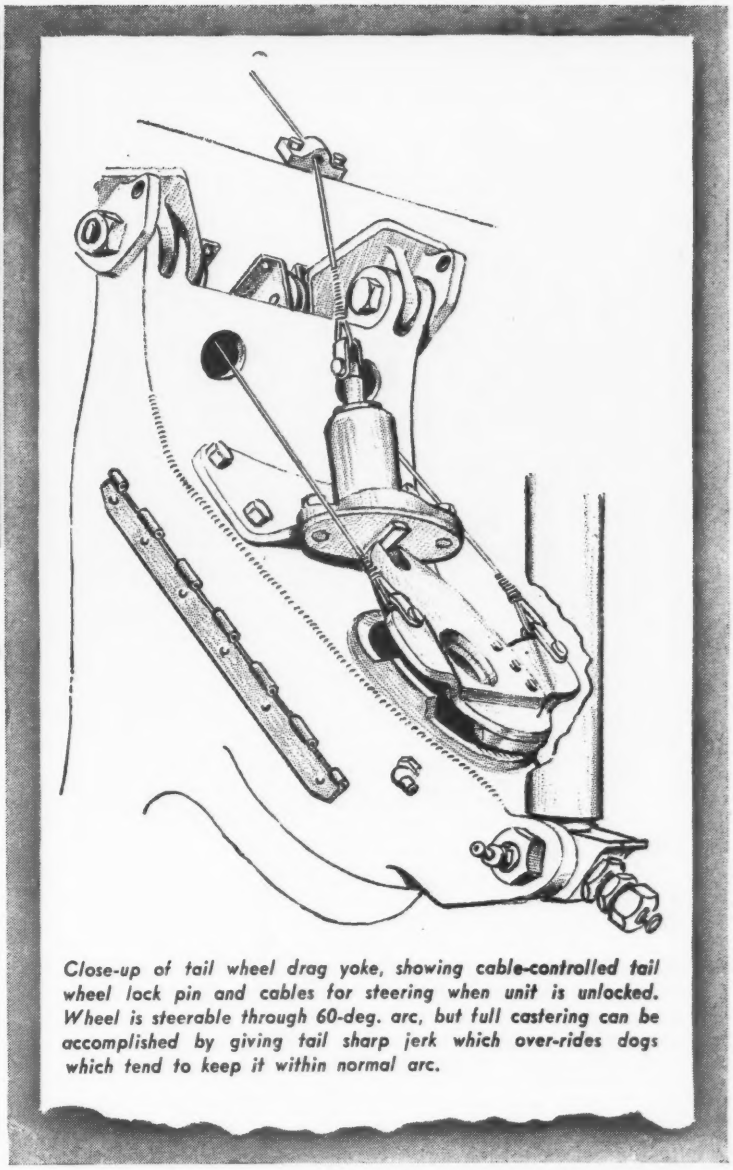
No de-icer boots are provided on the wings, the only anti-icing equipment being a slinger ring on the propeller and a jacket within the oil radiator to heat carburetor air.

The 5-in. long squared wingtip is made of light alloy pressed in halves welded along the leading edge, and is full monocoque except for a light web chordwise web rib 9 in. from the trailing edge. The 12–16 v., 16 candlepower identification light in the leading edge is held in place by stove bolts screwed to captured nuts. The whole tip is attached by captured nuts fitted to the end wing rib.

Evidence of the desire to get clean aerodynamic design without regard to man-hours is shown by the hand grips attached to the front spars at the wingtips. In the lower skin a piano-hinged 3 x 5-in. plate is held flush with the surface by an adjacent thumb-lock quick fastener. By releasing the lock the plate may be pushed up, in turn releasing a pin latch which permits the



General view of tail wheel, with tail cone removed, showing castoring action of tail wheel, drag yoke and combination retracting-shock strut unit. Tail cone can be quickly removed with screwdriver by removing three quick fasteners, ten screws and piano hinge for attaching canvas dust catcher on each side. (Ricker photo)



Close-up of tail wheel drag yoke, showing cable-controlled tail wheel lock pin and cables for steering when unit is unlocked. Wheel is steerable through 60-deg. arc, but full castering can be accomplished by giving tail sharp jerk which over-rides dogs which tend to keep it within normal arc.

grip to be pulled down into vertical position. The grip is a T-section aluminum casting—with the top of the T forming part of the skin in retracted position—with two quarter-round wood blocks screwed in the flanges to give a semi-circular grip. The pivot end is nicely machined, and fits its retaining pin snugly.

In addition to this rather fanciful item, machined retractable tiedown rings are attached to the front spars near rib 11.

補助翼 Ailerons

Hamp's slotted type ailerons are of conventional design and construction, having a channel section spar, 15 light stamped ribs and metal-sheathed nose section, all fabric-covered and attached at three self-aligning ball bearing hinge points. Those on the Zeke 32 are 11 in. shorter than those on the original Zero. Trim tabs, adjustable only on the ground, are set near the inboard end of each aileron trailing edge.

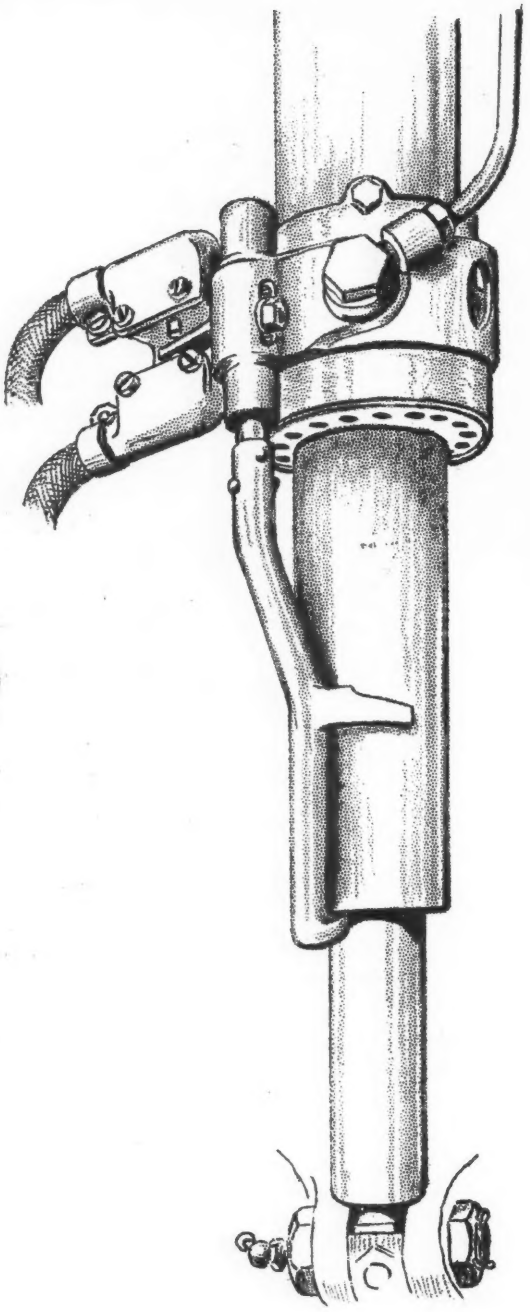
Flaps are hydraulically operated all-metal split type, with the skin flush-riveted to nine stamped, flanged ribs, a spanwise hat section stringer and a single spar which is combined with the leading edge by a heavy skin to form a torsion box. Flaps are attached to the false spar by piano hinges. The ribs are .020 gage; skin is .062 on the bottom of the torision box, .017 aft; and spar is .050 dural. This spar is not continuous, being broken to receive brackets holding the operating balance gear and the hydraulic cylinder, which is attached to the flap, with the piston attached to the false spar. A plywood strip is screwed onto the trailing edge for added stiffness with little extra weight.

Maximum deflection is 60 deg., but test flights have shown that 40 deg. gives the best glide angle. To insure balanced action, two ¼-in. cables are attached to high tension leads installed aft of the false spar and connected through bell cranks and push-pull rods. Operation of the flaps is indicated in the cockpit by a graduated slide operated by a thin flexible cable attached to the balancing bell crank on the starboard flap.

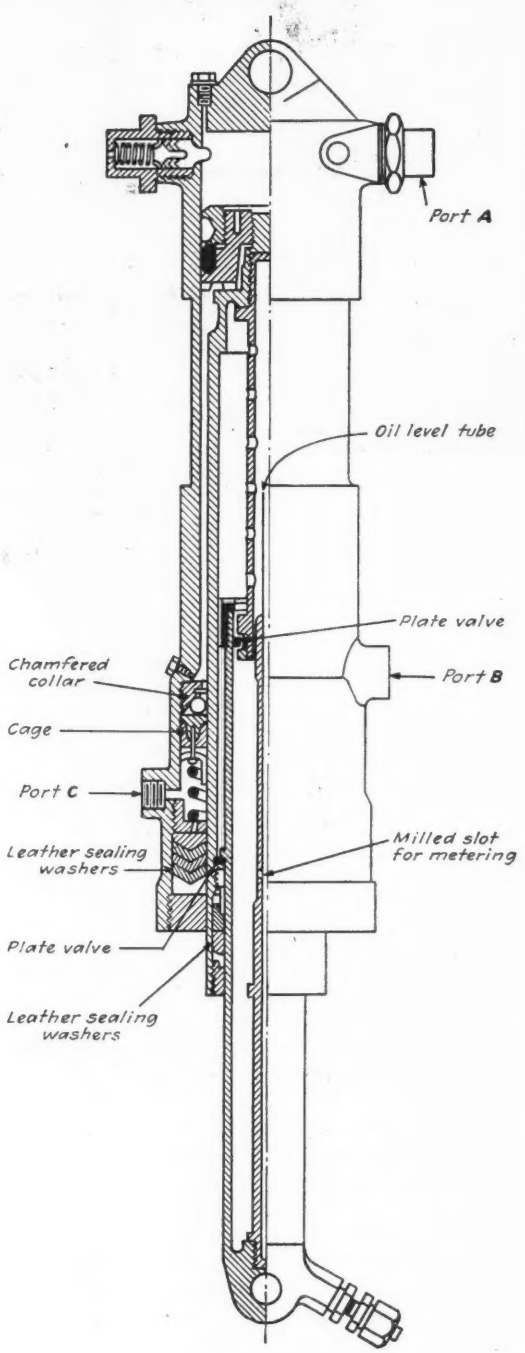
着陸裝置 Landing Gear

Outstanding feature of the main retractable landing gear is the mounting of the retracting jack to the shaft through eccentric bearings which, when the strut has completed the downward arc, brings the linkage through to a straight line position to form a positive mechanical lock.

To retract the gear, a cable attached to a cam controlling the lock arms is operated from an extruded arm on the landing gear selector valve handle. As this is moved to "up" position, the cam forces the lock arms from their position against the link plates as fluid pressure is passed to the rear of the



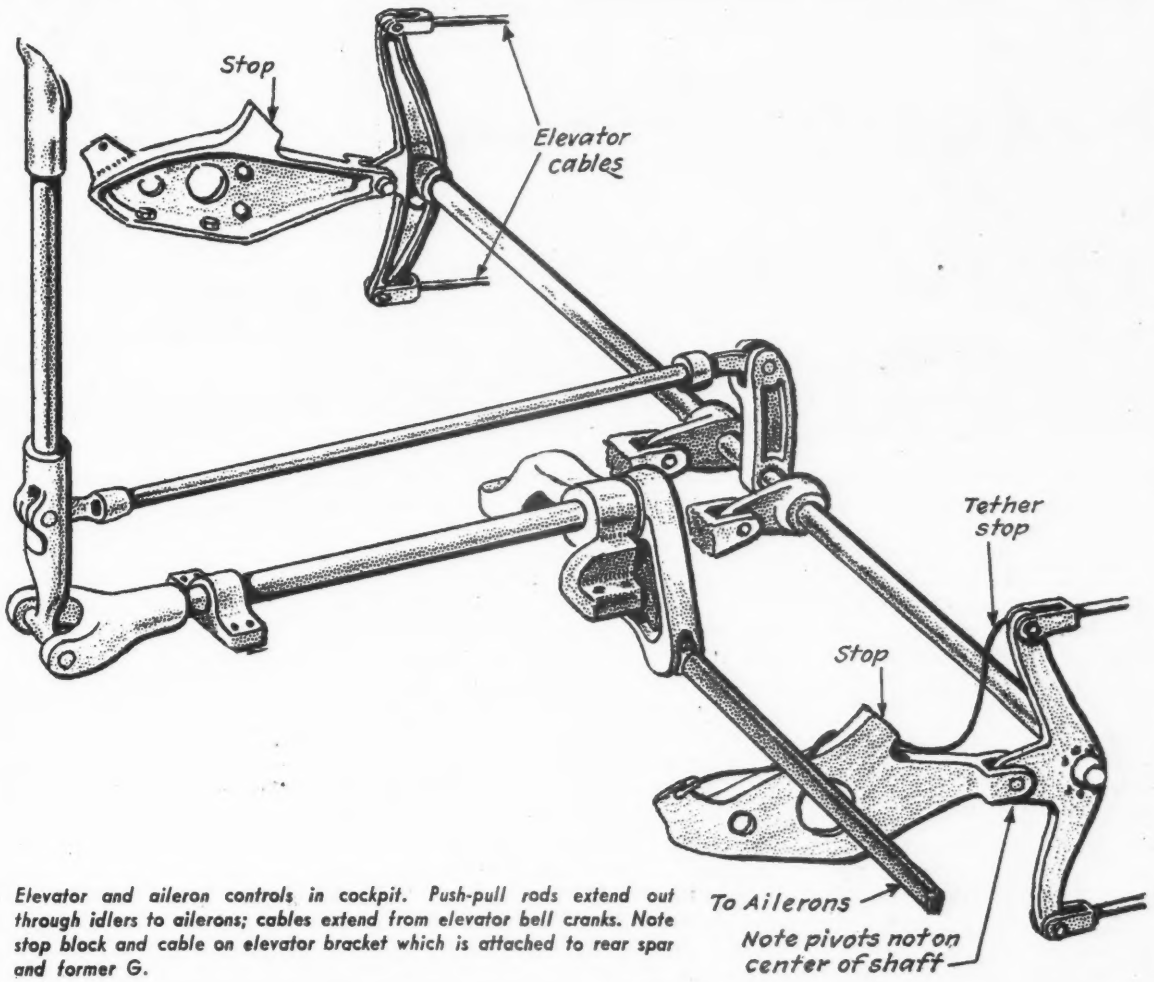
Sketch showing electric controls on tail wheel jack. Control tube at left has hook on bottom which shuts off power when jack is extended and bar which bottom fitting strikes when jack is retracted.



Cross section of combination shock strut-retracting unit on tail wheel, action of which is described in text.

3 x 5-in. cylinder. As the piston connection to the leg is in straight position, and the cylinder mounting or secondary shaft is off center at the eccentric, the pressure forces the cylinder backwards, rotating the shaft to bring the linkage from the straight position.

At the top of the arc a ring on the wheel fork catches a latch in the wheel well to lock it up, when a micro switch turns on a red light on the electric switch box at the pilot's left. The pilot must then return the selector valve to neutral position, otherwise the hydraulic pump will continue exerting pressure and the system will burn out. A warning horn blows if the pilot fails to neutralize the lever after the wheels are up and locked, but it doesn't blow if he forgets to lower wheels when coming in for a landing. A green light on the switchbox indicates wheels are down and locked; a yellow light indicates they're neither up nor down. There is also a small bayonet indicator which projects above the left wing to give the landing gear po-



Elevator and aileron controls in cockpit. Push-pull rods extend out through idlers to ailerons; cables extend from elevator bell cranks. Note stop block and cable on elevator bracket which is attached to rear spar and former G.

sition, similar to the Focke-Wulf 190.

Also on the wheel fork is a small trip and roller which closes and locks fairing attached to the fuselage belly so that retracted wheels are completely enclosed.

When the craft is on the ground and its weight causes the oleo to shorten, a flexible cable running from the right wheel up into the cockpit forces a small pin out behind the selector valve handle thus preventing its being moved into "up" position to retract the gear.

The landing gear has a spread of 11 ft. 6 in., and in extended position the legs toe in 2 deg. and the wheels toe out 3 deg. Brackets and fairing attached to oleo and wheels are of .040 gage. Typical of the light weight of the craft are the wheel and 23 x 6.9 tire, together weighing but 28 lb.

Brakes are hydraulically operated self energizing type with two shoes, 9½ in. long, 1¾ in. wide and $\frac{3}{16}$ in. thick operating on a steel drum riveted to the wheel. The brakes are usually operated by cables running from the rudder pedals, but some of the craft have the cylinders located in the fuselage. No parking brakes are provided, apparently just to save weight.

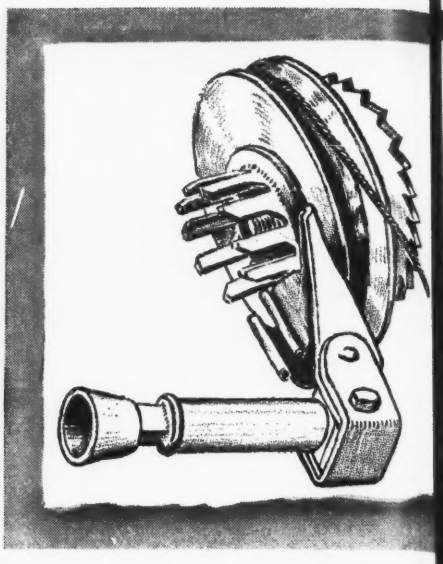
Landing gear legs are conventional steel forging construction, 3½ in. in diameter, with 3-in. diameter oleos having a 3½-in. stroke and operating under approximately 230 psi., mounted atop wheel forks of welded steel stampings.

The retraction unit is housed ahead of the front spar in a 21½ x 10½-in. section built up of ⅛-in. dural. Landing loads are carried directly into a short auxiliary spanwise spar and into the front spar by two heavy nose ribs and toward the rear spar by two interspar compression struts. The built-up section puts both landing gear leg and wheels forward of the front spar without bending it.

尾部車輪 Tail Wheel

The tail wheel unit is a combination retracting ram and air-oil shock unit, retraction being operated by the landing gear selector valve. The light alloy cylinder of the retracting unit houses a hollow ram, at the top of which is a piston head. Just above the compression glands on the piston head is a semi-circular groove, and when the ram is fully extended, two round headed spring-loaded plungers engage in a groove and keep the ram from moving outwards until pressure is exerted at the top port, indicated by (A) in the accompanying drawing. Right below the piston is another groove accommodating 14 steel balls when the ram is fully extended. The balls are retained in a cage towards the front of, but inside a packing gland, and are pressed up against a chamfered collar by a spiral spring against a glanded collar.

Arrester gear operating crank and ratchet, shown in closed and locked position in photo, with clip spring holding handle in locked position.



Sketch, with handle extended to operating position, shows radial ratchet which forms nut to hold pulley and ratchet in place.

The fluid pressure, supplied to the top port (A), is also connected with another port, shown at (C) in the sketch. This pressure, in conjunction with the spiral spring, pushes the balls against the chamfered collar, forcing them into a groove below the piston when ram is fully extended.

To retract the unit, pressure on the two ports (A) and (C) is released and applied to another lower port (B). Owing to the chamfered edge of the groove in the ram and release of the pressure, the balls are forced back into the cage and the ram travels back into the cylinder until locked by two plungers. All glands in this portion are leather, there being three main sealers of V-section forced between convex and concave collar by the gland nut.

The shock unit is in the retractor ram. From the piston end there is screwed a steel tube of ½-in. ID. and ¾-in. OD. A series of 3/16-in. holes are drilled through the sides, starting ½-in. from the end. About ¾-in. from the end is a shoulder against which is fitted a bronze collar with six 1/16-in. holes bored through the face and against which a plate valve works to control the six holes. The bronze collar becomes a piston fitting snugly into the bore end of the other portion of the unit which, in turn, slides into the internal bore of the retractor ram and becomes the shock absorbing ram at the end of which is a pivot pin hole for attaching to fuselage former V.

Up the center of the shock ram is fitted a hollow extension approximately ½-in. in diameter with a 5/32-in. steel tube right through the center and projecting 2-in. above the ½-in. brass column. Fluid is fed into the unit from a charging valve through the 5/32-in. tube which acts as a level tube. The brass column has a 1/16-in., 4-in. long groove tapering in depth from 3/32-in. at the top to 0 at the bottom. This tube is a snug fit with the tube fitted to the top portion of the shock unit, and in action is a metering pin.

On impact, the shock ram moves inward, compressing the fluid and closing the valve on the piston forcing the fluid through the metering pin groove, which in turn allows it to flow through the large holes in the side of the tube in which the pin travels, to the main cylinder space. On recovering, the compressed air forces the ram outwards, opening the plate valve and taking the fluid back into the original chamber.

The charging valve is situated in an offset on the end of the shock ram near the pivot hole. Gland packings in the shock unit are fabric and a little leather.

The lower end of this retracting-shock unit is attached to the aft end of the magnesium casting drag yoke, which is pivoted at its fore end to fuselage former V. Through this yoke a 3½-in. long vertical pin turning in ball bearings attaches the aluminum wheel fork casting. The tail wheel itself is 5¾-in. in diameter and 3-in. wide, and has a ¾-in. thick solid rubber tire. The bottom of the drag yoke is reinforced and shaped like a skid to reduce damage to the fuselage bottom in case the wheel stays retracted during a landing.

The tail wheel is steerable by cables from the rudder through an arc of about 60 deg., but full swiveling can be accomplished by giving the tail a sharp sidewise jerk which overrides the dogs tending to keep it within the normal arc. It can also be locked for take-off or landing by a cockpit-operated spring-loaded pin which drops into the front end of the steering horn.

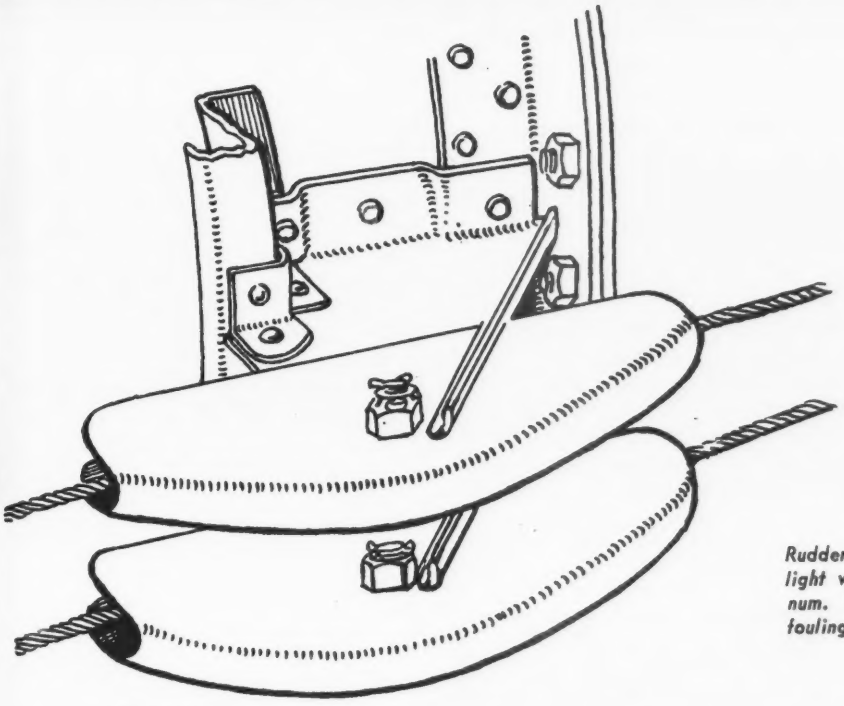
操縦装置 Controls

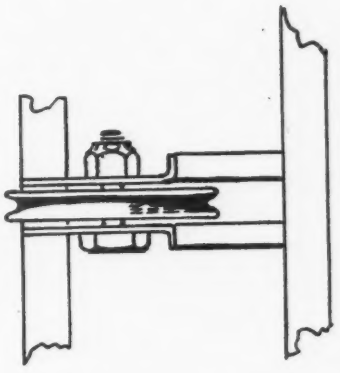
Controls present quite a mixture of the old and fairly modern, for bearings, as an example, run all the way from the plain to rollers, and the only way to repair some of the units is to completely replace them. And in some cases this is no 5-min. job, since most units are riveted in place. The control stick is made up of every light stampings and tubing, and apparently weight-saving was the dominant factor in its design.

Aileron control consists of yoke at the base of the stick with a tube held by two plain bearing brackets running aft under the pilot's seat to a bell crank set just aft of the rear face of the rear spar. Push-pull rods of 1¼-in. diameter run from there to bell cranks set in built-up brackets at the center aileron hinges. Idlers to prevent buckling keep maximum length of the rods to 50-in.

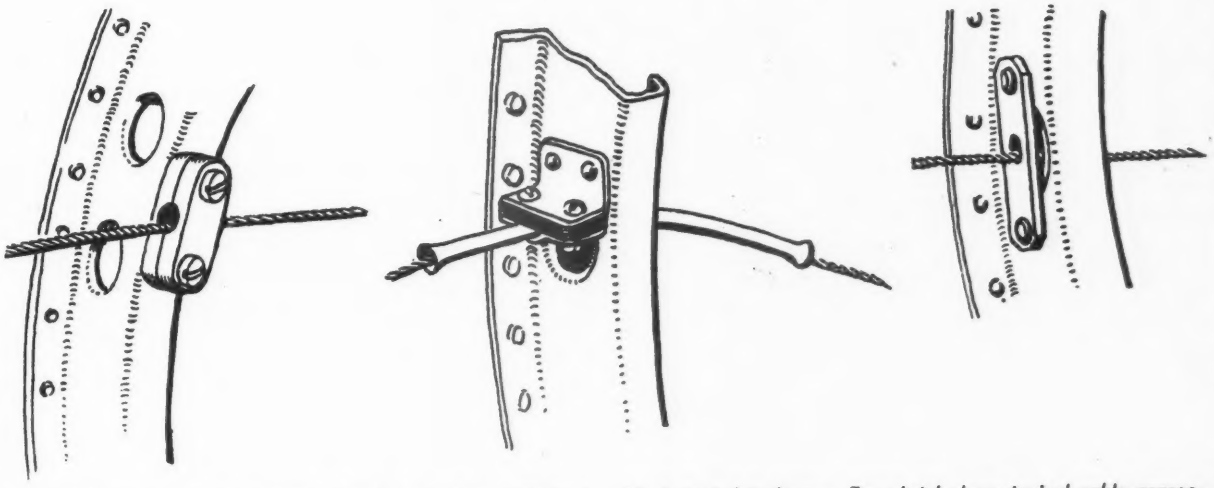
Elevator controls embrace a push-pull rod with rotating thrust bearing extending from the stick back under the pilot's seat to a self-aligning ball bearing bell crank held by brackets attached to the rear spar, with a torque tube extending out to bell cranks held by brackets riveted to the rear spar at the cockpit sides. These brackets have a built-in stop block to prevent pushing the stick too far forward and a cable stop limiting its backward motion.

Pivots of the bell cranks are set about 1 in. ahead of the spanwise tube, so that the cranks move up and down as the stick is moved. Quarter-in. cables extend from these cranks back through





Rudder sheave brackets are typical of light weight, being made of .040 aluminum. Very thin aluminum guards prevent fouling with fuselage flotation bag.



Three different types of fairleads found in fuselage. That at left is made up of two fiber blocks screwed together and bolted to former; center is copper tube flared at ends and clamped by two bolts to fiber spacer block; that at right is single fiber block riveted to former. Top sketch shows typical cable connection found throughout craft. Connection is standard bicycle chain repair link with drilled pins for securing cotter pin or wire. Loops are hand spliced around metal thimbles.

four different types of fairleads to the elevator horn.

Obsolete is the best word for the rudder control design. Cables are attached to a diamond-shaped plate—with the usual lightening holes—reinforced by riveted flanges, the whole unit being set in a bracket attached to the top wing skin which forms the cockpit floor. Atop the plate are riveted two tubes and a screw jack on the aft end of which is a six-spoke wheel to give pedals a 4-in. fore and aft adjustment. The rudder bar is simply a bent alloy tube welded to brackets fitting over the tubes, and pedals are riveted to lugs welded to the outer ends of the bar.

The hydraulic system is used only for the landing gear and flaps and is, therefore, a fairly simple unit. Pressure is supplied by a small gear-type pump driven by a gear train from the engine, and is regulated by a spring-loaded regulator valve adjustable between 782 and 853 psi. Excess pressure is by-passed through the valve into the 5¼-pint reservoir located in the fuselage behind the pilot. No accumulator is provided, pressure depending entirely on the pump.

燃料系統 Fuel System

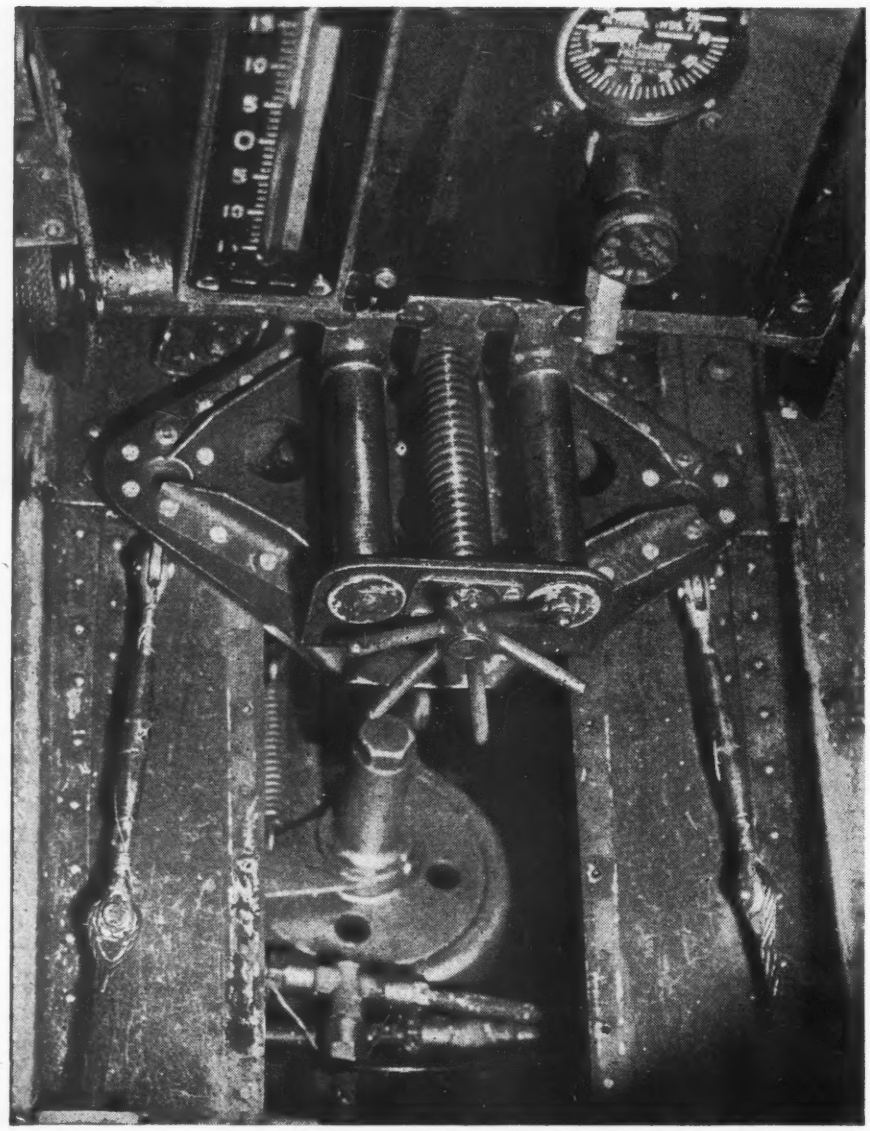
An emergency hand pump, located on the right side of the cockpit, is coupled in parallel with the engine pump. Pressure lines have gauze filters which can be removed and cleaned without loss of pressure. The selector valves are three-position type, using co-axial bronze valves operating in a bronze insert in a dural housing. Pressure is always applied to the top of the cone to insure positive seating.

Normal fuel capacity is 134 U. S. gal., with 20 in a 12¼-lb. fuselage tank set just aft of the firewall, and 57 gal. in each of two 24-lb. wing tanks set between spars and extending out 49½-in. from the root. All the tanks are light welded aluminum, are not self-sealing or protected in any way, and are not an integral part of the aircraft structure. Hookup is conventional parallel, with a 4-vane engine driven pump backed by an emergency hand pump, and no internal by-pass or regulator is provided. Small tank ventilators are set in the lower surface of each wing; apparently cooling is necessary to prevent vapor lock at high altitudes, since no booster pump is provided.

One of the two hydrostatic gages is connected to a two-way valve so that either wing tank can be measured; the other is for the fuselage tank. There are also two selector valves—one for wing tanks and one for fuselage and drop tank—with the cocks set in the wing center section and operated by a series of knuckle joints.

In the center of the front spar is a permanent fitting for an 87-gal. drop tank, a very clean little unit that leaves no projection outside the fuselage once the tank is dropped. Most drop tanks are light aluminum, but some of wood and even compressed paper have been used by the Japs.

The oil system includes a 13-gal. tank supported by welded lugs which bolt to the front of the firewall. The oil radiator is in a scoop just below the engine cowling, and shutters are operated mechanically through cables from a small crank on the right side of the cockpit.



Fore-and-aft adjustment of rudders is made by turning this six-spoke wheel which turns screw to move entire rudder bar, a simple bent tube welded to bracket attached to diamond shaped plate which contains typical lightening holes.

電氣裝置 Electric System

Light weight is again apparent in the two-wire electric system, current for which is supplied by an engine-driven generator and a 12 v., 20 amp. battery. Switches are simple but rugged, light wiring is used throughout, and conduits are small.

It is interesting to note here that in many places throughout the craft, conduits, wires and plumbing are not held in place by brackets, but simply by shellacked tape tied into lightening holes found practically any place.

Although Hamp's armament has been fatal to too many good Americans it is, compared with our fighters, lightweight like the rest of the craft. It consists, fortunately, of but two 7.7-mm. machine guns and two 20-mm. cannon. The machine guns, of comparatively low muzzle velocity, are built just like British Vickers. They have a free-firing rate of 600 rounds per min., but since they are electrically synchronized to fire through the propeller, their actual rate is much lower. The 30-mm. cannon are also of fairly low muzzle velocity and set outside the propeller arc, fire 100 rounds per min.

Low density honeycomb core seen here was produced in blocks, band-sawed to required thickness, then saturated with additional resin by dipping. Flexibility, tackiness, and edgewise compressibility of core permits very rapid placement.

All-Laminate Construction Bids for Aircraft Uses

By LEONARD S. MEYER, *Associate Director of Engineering Research, and*
JOHN C. CASE, *Research Engineer, Plaskon Div., Libbey-Owens-Ford Glass Co.*

Here are informative details of the experimental production of a complete fuselage section formed of a new structural material. Composed of resin and glass cloth, this product is seen offering interesting possibilities for mass-fabrication of aircraft components.

THEORETICAL ADVANTAGES OF THE sandwich-type aircraft structures are well known, and in the past, plywood, metal, and combinations of wood and resin-laminate constructions have been utilized.

But, for the first time, a representative structural part has been fabricated with all-laminate sandwich construction—including core material. Strength characteristics were found to be more than adequate, and fabrication on an experimental basis was relatively fast and certain.

Origin of Project

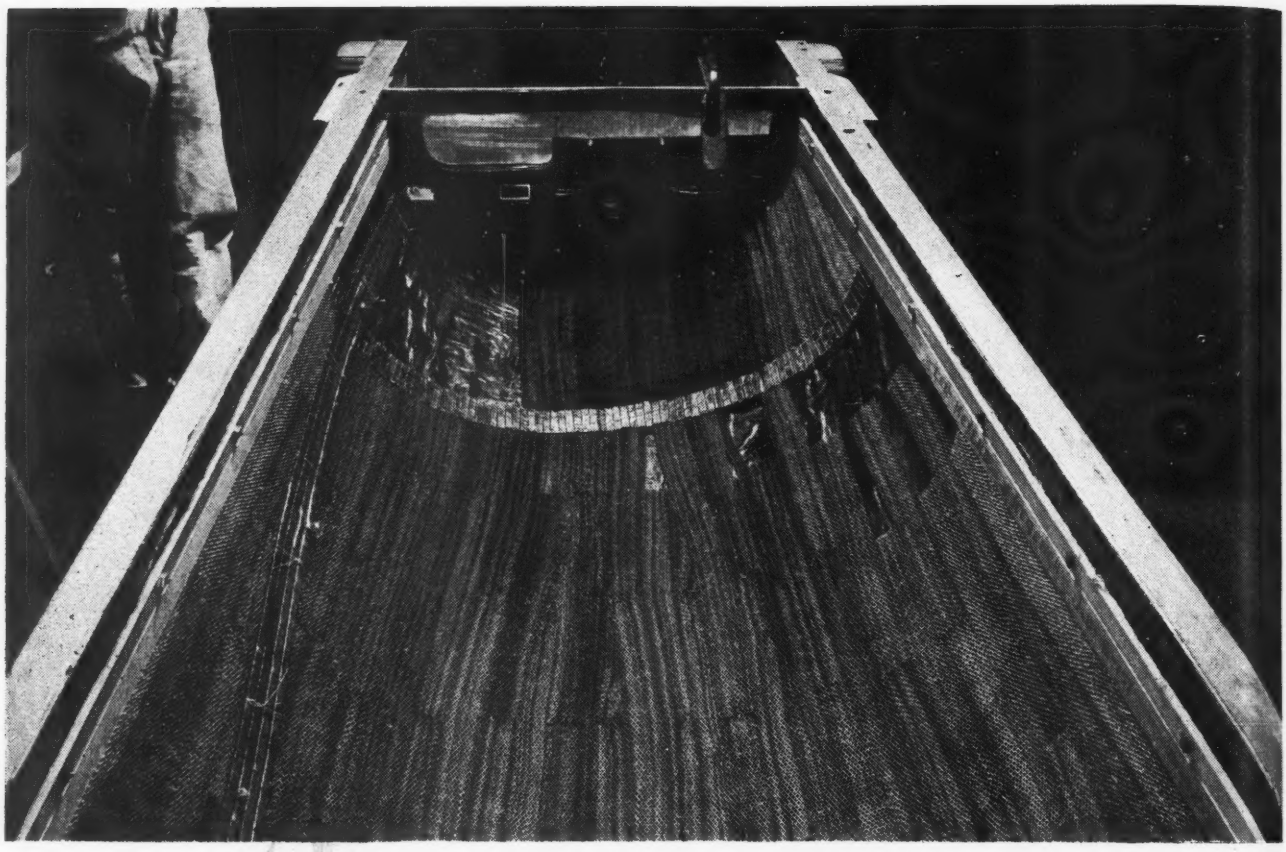
Experimentation under the auspices of ATSC aircraft laboratory at Wright Field had established desirable strength-weight properties [1] of resin-glass cloth laminates and their usefulness as the skin in sandwich constructions.[2]

Experimental fabrication at the aircraft laboratory culminated in the construction of primary stressed aircraft parts, most prominent of which were a number of Consolidated Vultee BT-15 fuselage sections.

While these parts adequately met static, impact, firing, and flight tests, their usefulness as a demonstration of laminate construction was impaired by the employment of some wood—notably balsa as the sandwich core, and spruce as stringers and compression pads. Also, tail wheel assembly fittings were attached to a plywood bulkhead.

Obviously, the use of wood—because of its lack of decay resistance, its

[1] References are tabulated at end of this article, page 144.



Shown is half-mold with outer skin, half of rear bulkhead preform, honeycomb core, and tubular higher density core in place. Note features of edgewise compressibility and flexibility of honeycomb core for easy placement.

dimensional instability, directional properties, and variability in weight—limited the general acceptance of sandwich construction employing it.

Subsequently, several synthetic materials, such as celular hard rubber, celular cellulose acetate, and foamed thermosetting resin compositions, had been advanced as sandwich core materials. These, however, if adequate for low density cores, still leave unsolved the problem of eliminating wood from the more highly stressed compression areas.

Resin research and application technique experimentation in the laboratories of Libbey-Owens-Ford Glass Co.'s Plaskon Div. led to the production of samples of cellular all-laminate honeycomb core materials. The ease with which these could be produced, the identity of their composition with that of the laminate skins, and the possibility of production in any weight and strength up to that of solid laminate, led Wright Field personnel to request that Plaskon undertake the experimental production of all-laminate fuselage sections and to deliver a number of these for test purposes. And under the resultant contract, a complete BT-15 fuselage rear section was constructed of resin-glass cloth laminate employing no wooden inserts.

The use of metal was limited to fittings necessary for attachment to the remainder of the airplane, and such rivets or bolts as were required for their assembly—this much being dictated by the original design of the metal plane.

To date tests of this construction have been limited to complete static

Table I—Static Test Results

Construction material	Weight (lb.)	Effect of 100% of design loads	Percent design load at failure (tail wheel side load)	Strength-weight ratio
Aluminum alloy.....	70	No failure—visible buckling in some cases	105	1.00
Wood and plywood.....	86	No failure—visible buckling in some cases	110	.82
Glass cloth laminate with wooden core sandwich construction	78	No failure.....	180	1.50
All resin-glass cloth laminate sandwich construction	75	No failure.....	180	1.55

Table II—Design Data and Safety Factors

Construction material	Properties determined	Values recorded	Values employed in design	Safety factor allowed—%
Solid laminate of "heat-cleaned" ECC-112 glass cloth and Plaskon 911 resin	Edgewise compression	40,000 psi.	20,000 psi.	100
	Tension	45,000 psi.	30,000 psi.	50
	Bearing	50,000 psi.	30,000 psi.	67
	Shear	15,000 psi.	5,000 psi.	200
Bond of new laminate to previously cured laminate	Shear	2,000 psi.	1,000 psi.	100
Sandwich with ¾" low density core and 7 ply ECC-112 glass cloth faces	Edgewise compression	1,000 lb./in.	Stress data inadequate to determine.	
	Flatwise compression	900 lb./in.		
	Tension normal to faces	400 psi.	200 psi.	100
Sandwich with ⅜" high density core and 7 ply faces	Flatwise compression	1,800 psi.	Stress data inadequate to determine.	

and ground firing tests, and all were satisfactory. Additional fuselage section for flight test and study are under construction.

This BT-15 rear fuselage section has now been produced in four types of construction—aluminum alloy, wood, glass-laminate and wood combination, and finally, the all-laminate makeup. Interesting comparison of static test results for these four constructions are shown in Table 1.

Materials of Construction

The complete fuselage section was built of Plaskon 911 resin-glass cloth laminate, with the exception of rivets, tail wheel and stabilizer attachment fittings, and front attachment washers. Total weight of metal involved was 3.3 lb. and weight of complete fuselage section was 75 lb.

Four types of the laminate construction were employed:

(1) Solid glass cloth laminate for sandwich skins, rear bulkhead, and front band for attachment of fairings.

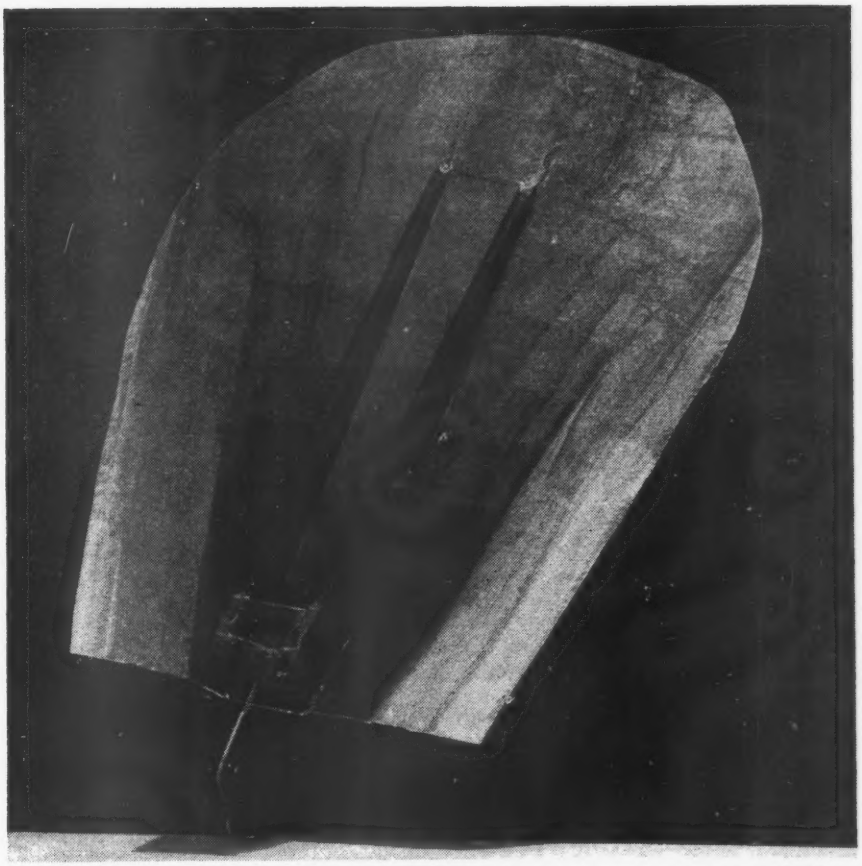
(2) Low density honeycomb core weighing 9 lb./cu. ft., used in $\frac{3}{8}$ in. thickness for the bulk of sandwich core and for core in the stiffening bands.

(3) Heavier honeycomb core used under the stabilizer attachment fittings only, to withstand rivet pressure.

(4) Tubular higher density core employed under the rear center stiffening band and for two longitudinal core stringers about 3 in. wide extending from the front attachment fittings to the rear bulkhead.

Engineering Data

Conforming to design tradition of using previously determined physical constants combined with data on anticipated stresses, constants for the types of construction to be employed were first determined on sample products.



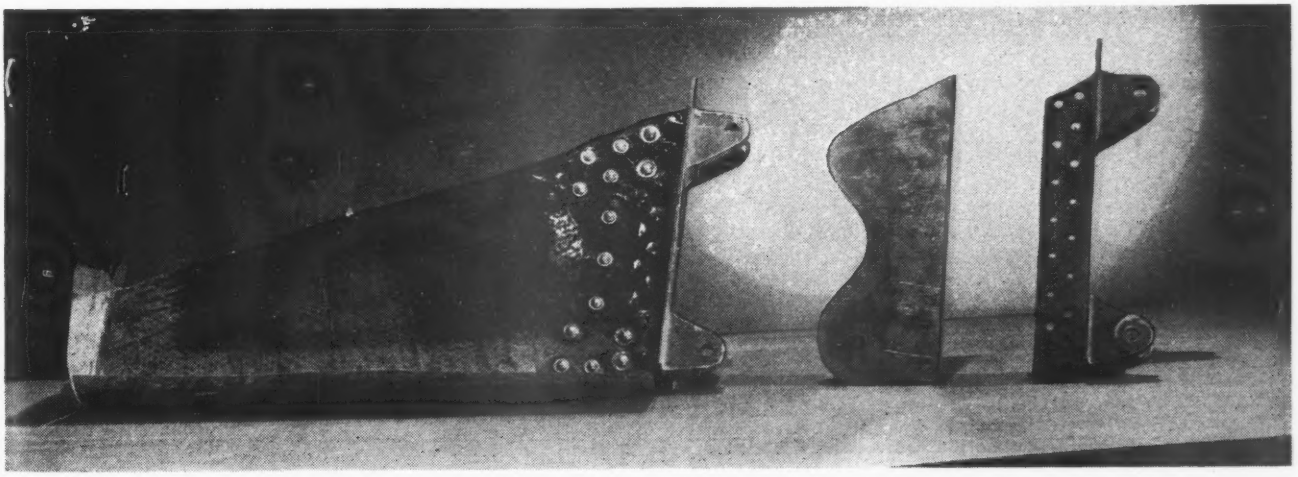
One of three front attachment fittings for bolting laminated fuselage section to front fuselage section. Light behind translucent laminate shows how section density was tapered to meet anticipated stresses. In final molding operation, prefabricated units were "welded" integrally with sandwich skin and cores.

Data obtained and safety factors employed are shown in Table II.

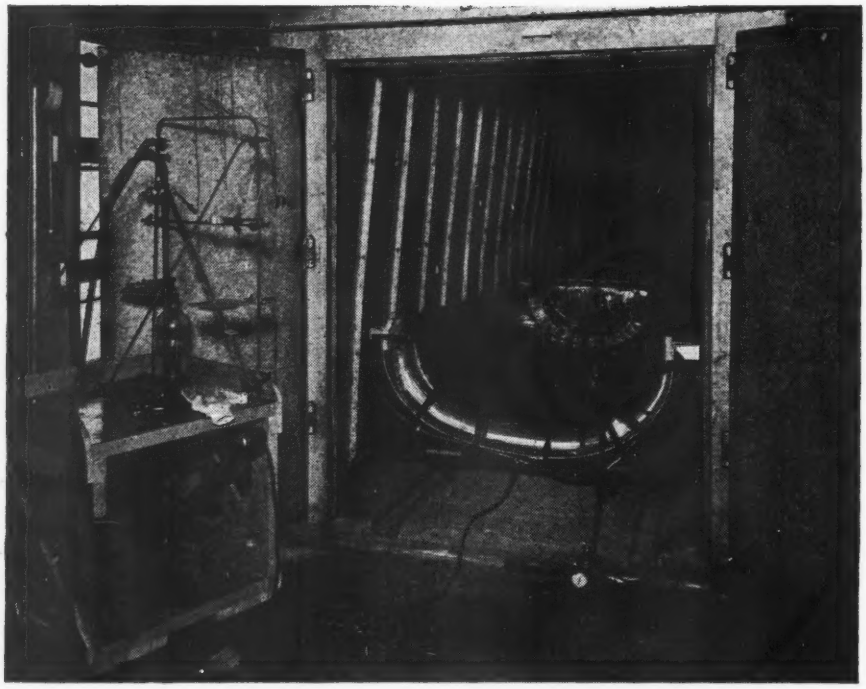
The fuselage section was fabricated in two halves and then assembled—not that this was indicated as the best procedure but because molds for the halves were available from earlier work at Wright Field whereas a full mold was not available.

Individual components of core materials, rear bulkhead, front and rear stabilizing ring cores, rear reinforcement spars for tail wheel assembly attachment, and three front attachment fittings, were prefabricated of laminate, then incorporated in one operation into the complete half structure.

In producing each fuselage half section, a simple procedure giving consistently satisfactory results was followed. The steps involved are:



Tail wheel metal attachment fitting was molded, then riveted, to rear laminated spars. Like other prefabricated parts, this unit was finally molded and cured into fuselage section.



Seen in oven for final cure, fuselage half section has prefabricated fittings, bulkhead skins, and sandwich core in place, and is covered with flexible transparent blanket of polyvinyl alcohol. Pressure was applied by evacuating air between mold and blanket.

(a) Lubricate the mold with thinly applied solution of Vejin A3.

(b) Apply the outer skin, pre-impregnated and laid up fabric layers (7 ply ECC-112).

(c) Place all core materials.

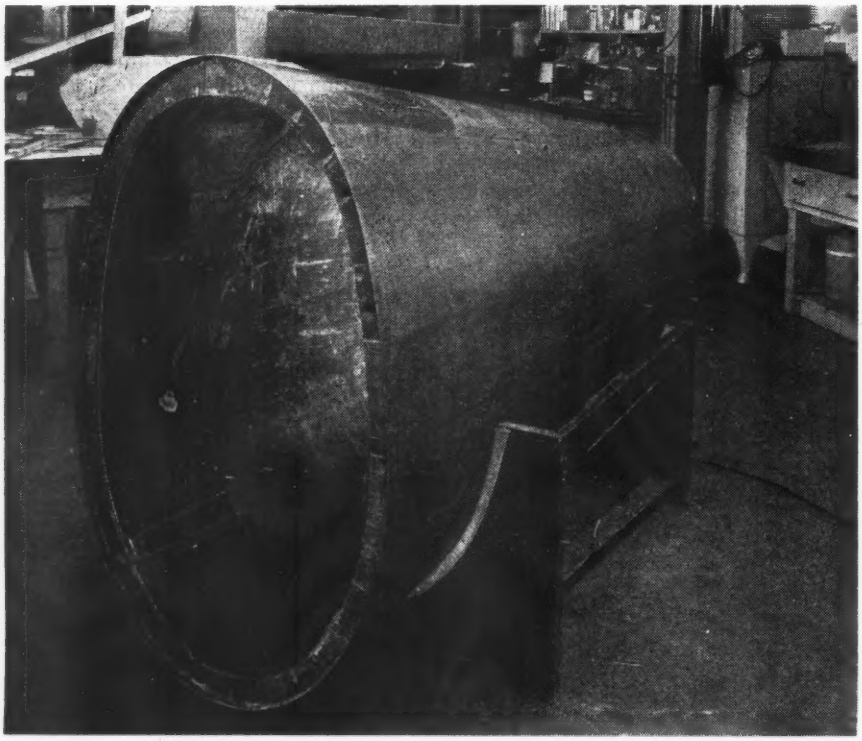
(d) Place prefabricated components—beams, bulkheads, attachment fittings, and rear and front frame cores.

(e) Apply inner skin (mostly 6 ply ECC-112). The gradation of thickness was employed in some areas to meet anticipated stresses.

(f) Cover complete assembly with a thin polyvinyl alcohol blanket, and seal edges of blanket to mold above the "lay-up".

(g) Apply vacuum between blanket and mold, thus putting pressure on the lay-up. The blanket is allowed sufficient excess so as to mold firmly around all fittings.

(h) Cure or weld the lay-up into one complete structure by means of oven-baking.



Completed fuselage section after two half portions had been welded into single unit by final molding operation. Prefabricated fitting seen (lower left) in fuselage interior, has become integral part of structure.

Many Advantages Seen

It is believed that the outstanding strength-weight ratio of this all-laminate construction, combined with its smooth exterior surface and extreme stiffness, will be of interest to aircraft engineers.

Questions raised will involve fabrication methods. It is believed that many advantages can be demonstrated through the use of this new structural material in judicious combination with metal, and that the following enumerated advantages make it of great potential value:

(1) *Prefabrication possible.* As in all-metal construction, component parts may be readily produced in widely separated plants, and finally assembled as a complete structure.

(2) *Mass production methods feasible.* Sandwich core material may be readily corrugated and assembled, and cheaply produced with semi-automatic machinery, in any desired weight and thickness.

(3) *Results consistently uniform.* Easy cure of the resin—whether enclosed or exposed to air—coupled with its "tackiness", enables core, skins, and subassemblies to be easily placed and held in place, and guarantees consistent production results. For example, in the present experimental program, no fuselage section or half section had to be discarded. The first two produced were assembled and met all static tests.

(4) *Simple and structurally sound repair.* Damage by gunfire of the all-laminate construction was less than for either wood or metal. Also, the simple technique of repairs, involving no equipment not easily available in the field, offers a great advantage over metal for many parts.

(5) *Availability of materials.* Both constituents of the construction— resin and glass cloth—can be readily expanded in production from most available raw materials, to meet conceivable demands.

References

[1] *Development of Glass-Reinforced Low Pressure Plastics for Aircraft*, Col. Paul H. Kemmer, p. 89, *Modern Plastics*, May 1944.

[2] *Application of Glass Laminates to Aircraft*, Capt. George B. Rheinfrank, Jr. and Lt. Wayne A. Norman, p. 94, *Modern Plastics*, May 1944.

Centralized Vs. Decentralized Aircraft Research Organizations

PART V OF A SERIES

"Organized industrial research is the highway to the hilltop of economic progress—the pathway trod by the majority of successful business enterprises."

By K. R. JACKMAN, *Chief Test Engineer, Consolidated Vultee Aircraft Corp., San Diego*

Herein, Author Jackman first weighs the advantages and disadvantages encountered when research activities are organized in the "concentrated" form, then he applies the same yardstick to the "separate-function" type of setup. And finally he considers the work of specific governmental and industrial research organizations, citing the values afforded through cooperation of these agencies.

CONTINUING OUR DISCUSSION of aviation laboratory organizations, prewar and postwar, let us now consider the centralized as compared with the decentralized form.

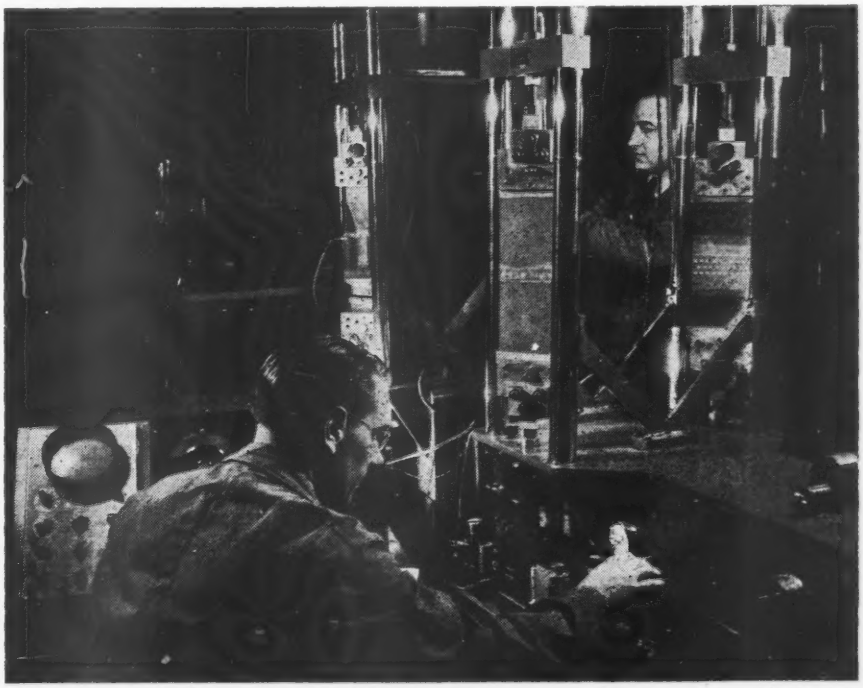
As may be noted in Fig. 2 of Part IV (page 141, Apr. AVIATION), it apparently was found expedient to decentralize research and testing within the engineering department of this 1940 Lockheed organization—that is, into structures research, flight test research, and aerodynamic research. With the increases in the size and complexity of wartime organizations in the last few years, there has, in some instances, been a tendency to increase decentralization of testing and research functions.

On the occasion of the celebration of the 25th birthday of the central research organization of the Standard Oil Co. last year, it was pointed out by Clyde Williams[IV-4] that this company is one of the pioneers among the larger industrial organizations in establishing what are now known as "central research" departments. Although a few of the more research-minded corporations, such as American Telephone & Telegraph and General Electric, had central research departments before the last war, and several others had well-organized departments, the movement did not really get under way until Standard Oil and several other organizations, at the close of or shortly after World War I, established highly-organized central research departments, thus starting a trend which has gained impetus with the years.

It is largely to these well-organized and effective central research departments that America and the world owe their debt for the outstanding production of war material that is bringing victory for the Allies.

Williams[IV-4] lists the principal requirements for the successful research laboratory as "suitable personnel, good management, and a well-equipped plant." The personnel should be trained not only in the primary fields of interest but also should become expert in other fields so that they may give advice and consultation and may direct activities in allied or fundamental fields of interest. The management should be so staffed as to be able to direct the technical phases of the research work in order to keep it in productive channels and recognize its commercial possibilities. The research laboratory should have all the necessary equipment to enable the technical staff to carry on its work efficiently and with as much saving in labor and time as possible.

Centralization of aircraft research functions has advantages and disadvantages over a decentralized laboratory, the particular local situation in each aircraft organization dictating the



Riveted and welded joints under study at Battelle Institute. Cooperative research concerned with methods of fastening aircraft structures will yield benefits to the entire industry, since approximately 30 percent of building time is consumed in making joints. (Battelle photo)

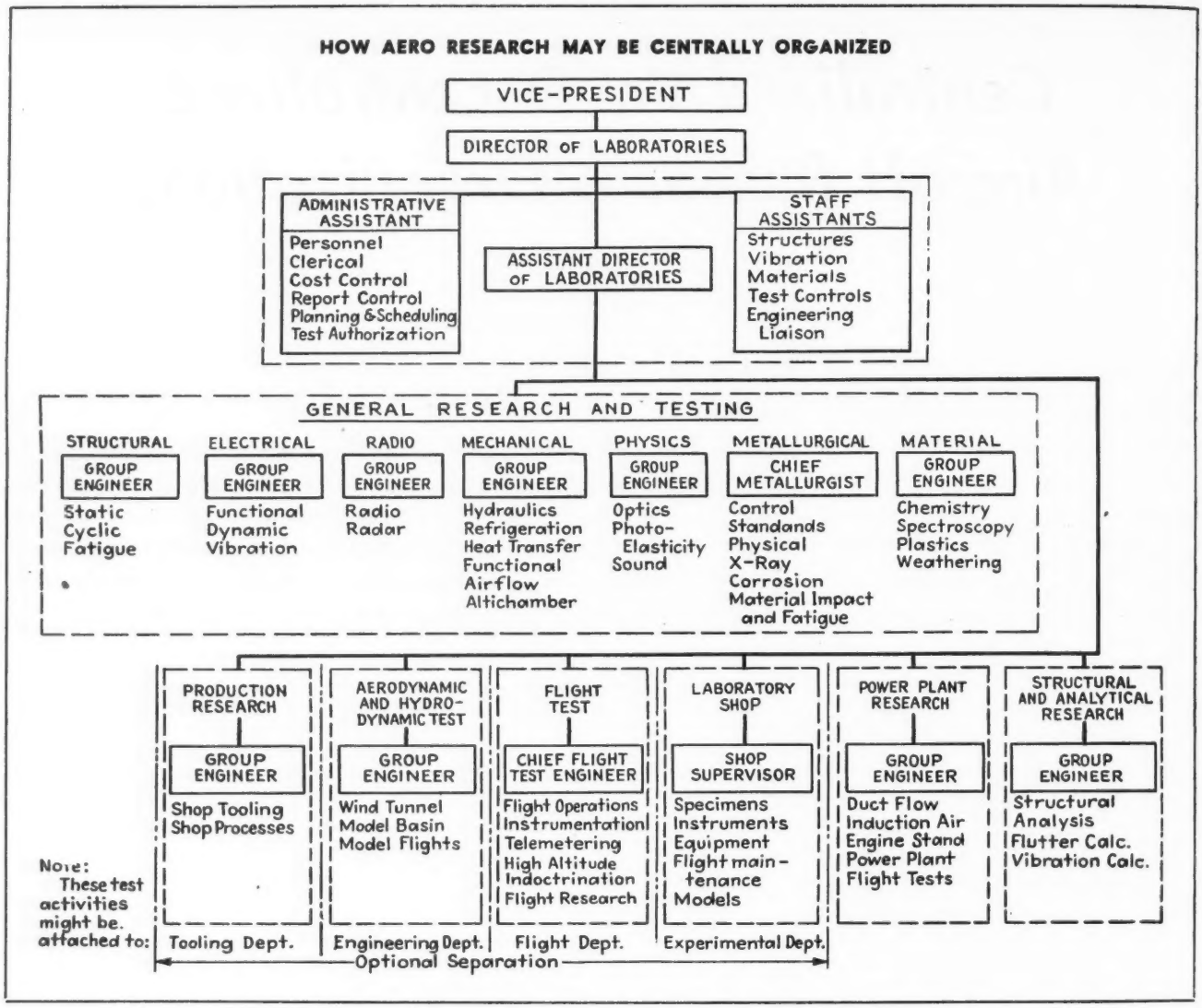


Fig. 1. Shown here is manner in which aircraft test and research facilities might now be feasibly centralized to promote postwar efficiency and economy.

weighting of the "pros" and "cons" and the final choice of organizational setup.

Let us consider, for a moment, some of the major advantages and disadvantages of the theoretical centralized laboratory organization shown in Fig. 1 (recognizing, of course, that the reverse will be true for a decentralized laboratory; the "pro" for one is the "con" for the other):

Advantages: 1. Prevents duplication of personnel, equipment, and area.

2. Permits unified control policies and reports.

3. Permits flexibility of use of manpower and equipment on high-priority projects.

4. Permits greater economy.

5. Permits strengthening of research personnel in experience and morale by a constant flow of projects.

6. Permits concentrated effort in meeting competition from outside companies.

Disadvantages: 1. Joins dissimilar test functions, such as wind-tunnel tests, structural tests and flight tests, which conventionally are maintained as separate functions.

2. Tends to become large, unwieldy, and given to "red tape" if "staff system" is not applied.

3. Throws heavy burdens on director and assistant director if administrative assistance is not forthcoming from subordinates.

In a fair analysis of the type of research laboratory suited to an aircraft company, the above considerations, together with the physical locations of the various functions, size of groups, and availability of natural leaders, must be carefully considered. The most questionable test functions of Fig. 1 have been shown in a position where optional separation may be made from the central laboratory and affiliations may be made with more conventional departments.

In order to meet the postwar demand for economy, for small but strong test functions, and for flexibility of the technical staff and engineers, chemists, metallurgists, etc., it is believed that considerable centralization of research and test functions within large aircraft manufacturing organizations is beneficial and will be a natural trend with the curtailment of current lucrative war contracts.

It is also believed by the writer that the separation of the research laboratory from engineering—to act as an unbiased test and development agency for other departments of the company or for other divisions of the corporation, and to report as a separate department to a vice-president of the company—has merit and should be seriously considered in any postwar research organization.

Factors of Efficiency In a Centralized Research Laboratory

Flexibility and a minimum of "red tape" are incorporated in the centralized research organization (Fig. 1) through the proper functioning of a

practical administrative group and the "staff assistants" group. (Simplification of laboratory procedures, report control, planning and scheduling, cost control, and other administrative functions, will be individually covered in future articles in this series.)

The importance of the proposed "staff assistants" group (Fig. 1) should not be overlooked, since these specialists compose the heart of a large, flexible, efficient, centralized laboratory. Each of these men should be expert in his respective field, such as structures, vibration, aerodynamics, materials, power plant testing, etc., and together they would form a departmental committee, with the director and assistant director to consider all major incoming projects, allocation and budgeting of work, laboratory policies, origination of research, etc. Inasmuch as these men are without group responsibilities, they could effectively carry on liaison and expedite test projects in laboratory groups with which they are affiliated by their specialized field.

For instance, the "structures staff assistant" could help the director—who, after all, will be busy with management, policy, and budgetary matters—by contacting the structural group (tests) and the structural and analytical group (theory and mathematics) and correlating the common problems. Test reports, and also reports to management on specialized work, would be accepted and signed by the proper staff assistant before being circulated by the director.

Although many tests and research laboratories of aeronautical engineering departments are closely associated with an experimental or shop department, which builds prototype airplanes and test specimens, it appears desirable, from the writer's experiences, to attach a laboratory shop to the centralized research department. Only by such an organization can high-priority developments and tests be scheduled and expedited, independent of conflicting production demands.

There are probably many laboratories in which complete or partial centralization of testing and research may not be advisable. Most aircraft research laboratories are decentralized to some extent, though the trend appears to be to concentrate facilities for economy. In the Consolidated Vultee Aircraft Corp., for instance, as with many large aircraft companies which have been forced to expand rapidly in the last few years, it has been convenient, in the interest of mass production, to decentralize to a large degree, both organizationally and also in physical locations (as shown in Fig. 2). Administrative personnel for each of the test functions has grown, with the corporation, in each separate laboratory and has adequately handled the separate functions.

U. S. Research Laboratories

The largest research institution in the world is that maintained by the U. S. Dept. of Agriculture, which has experimental stations in various parts of the country supported partly by the individual states and partly by funds from the federal government.

The National Advisory Committee of Aeronautics is the agency established by Congress to promote aviation through research. This organization has three large laboratories, one at Langley Field, Va., for wind tunnel and structural research; one at Moffett Field, Calif., for wind tunnel and flight testing; and one at Cleveland, Ohio, for engine research.

In peacetime, the NACA laboratory facilities are partially used on problems of direct interest to the aircraft industry as a whole, whereas in wartime they are used exclusively for Army and Navy problems and there is only a nominal amount of coordination with the aircraft industry.

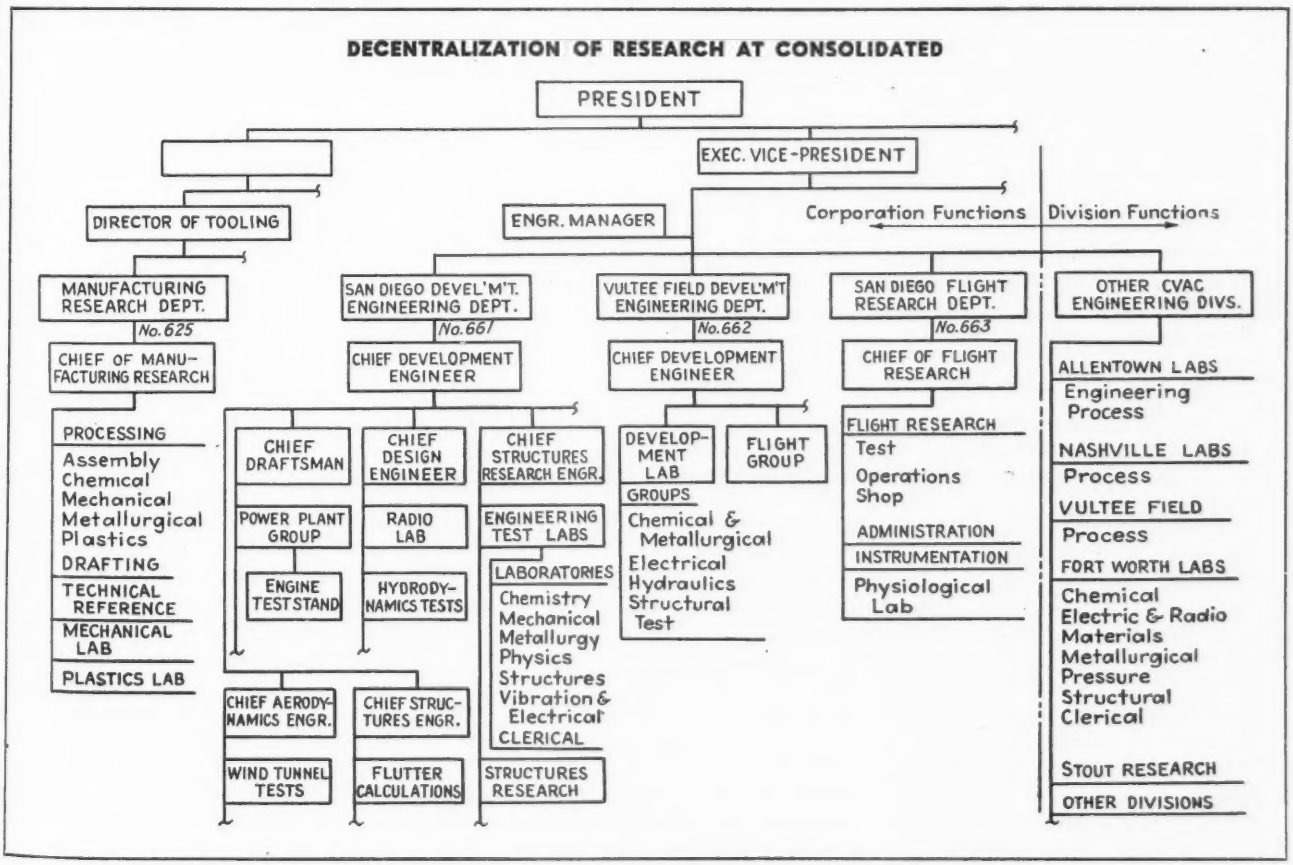


Fig. 2. Both organizational and locational decentralization will be noted in this chart of Convair's test and laboratory distribution. By means of this type of setup, certain advantages are afforded in wartime production and research activities.

An interesting, but seldom-mentioned, laboratory is that maintained by the Federal Bureau of Investigation of the U. S. Dept. of Commerce. The functions of this "Technical Laboratory" include: Blood examinations; toxicological examinations; firearms identification; glass fractures; latent fingerprint identification; powder patterns (gunpowder or blast); number restoration on documents, currency, or firearms; examination of documents (hand writing, typing, erasures, etc.); bombs and explosives; microscopy; spectrography; and metallurgical examinations.

Those in the aircraft research laboratories who have been referees or investigators in cases of suspected sabotage or relative to acts of carelessness in aircraft factories, in which the FBI inspectors are asked to make an investigation, realize the careful, yet rapid, judgments that are required of these men, based sometimes on the local aircraft laboratory findings but more often on the results determined by the FBI Technical Laboratory in Washington, D. C.

It is interesting to note in a 1942 pamphlet [V-1] on this laboratory that "as the laboratory expert rises in distinction, and increasingly gains the confidence of the investigators, of the prosecutors, and of the court, his testimony will have an even greater value than at present. Of course, he must be of unquestionable character and unbiased, so that after a disinterested methodical study of the evidence (a study often made at a place remote from the scene of the crime), and without any knowledge of extraneous facts in the case which at times might tend to affect his best judgment, he can arrive at a conclusion as to the existing conditions and interpret them in the best interest of justice."

Wide Discretionary Powers

The aircraft companies, through their research and engineering departments, work cooperatively with the Army Air Forces and the Navy Bureau of Aeronautics to obtain information on which specifications for new aircraft can be soundly based. The AAF and BuAer, as the largest sponsors of research and new prototype airplanes in the last few years, have permitted the prime contractors wide discretionary powers as to the details of the research and development work which can be done to obtain the final product.

Wright Field,[V-2] headquarters of the Air Technical Service Command, like other large buying agencies such as Macy's and Sears Roebuck, writes its own quality specifications for what it wants. And then manufacturers produce merchandise in the form of prototype planes specially to meet its requirements. Since Wright Field buys only products that meet it specifications, it maintains enormous test laboratories to check the products.

To pursue test and research work, Wright Field is given an annual appropriation by the Army, from Army funds provided in Congressional appropriations. Since 1939, when Congress began loosening purse strings to make the building of a preëminent American Air Force possible, the ATSC headquarters has placed over $50,000,000,000 of orders.

Construction of the Patuxent River Naval Air Station,[V-4] at the junction of the Patuxent River in Maryland and the Chesapeake River, marks the first base where the U. S. Navy can combine and concentrate the flying and operating aspects of experimental work in aviation. This experimental center is the Navy's counterpart of the Army's Wright Field. Several thousand officers and men make up the full staff to use the 45 buildings at the station. In connection with its work for the development of better aircraft, it will take over experimental work previously conducted at the Naval Air Station at Anacostia, Md., and Norfolk, Va., and at the Naval Aircraft Factory at Philadelphia, Pa.

NAES Has Six Departments

The Naval Air Experimental Station,[V-3] was set up in 1924 as a part of the larger Naval Air Materiel Center (NAMC) to prove that naval aircraft parts are "best by test," and now it ranks as one of the best aeronautical experimental stations in the world. NAES is divided into six departments which deal with engines, materials, instruments, radio and electricity, medical problems, and general service.

The degree to which a large laboratory can be subdivided, and the specialization of each section, are best shown in the organization of the National Bureau of Standards [V-5] at Washington, D. C. In Fig. 3 is depicted the elaborate line-and-staff organization of this research institution, subdivided into four functional divisions: Research and testing, commercial standardization, ordnance development, and administration.

When confronted with such massive centralization, together with the numerous bureaus common in government research and testing organizations, the writer often questions whether too much organization and administration is not as bad as too little, and whether in such institutions there is not a real danger that the office, which should be the servant of the investigator, may become the master.

Factors in Coordinating Research and Testing Activities

In 1939, Bernal,[II-6] of the University of London, bemoaned the fact that inefficiency and the imperfect organization of individual research laboratories is by no means the most serious disability from which scientific research in England suffered. He found that even more important was the general lack of coordination between the different scientific institutes and between individual research workers in different places.

"What organization of science exists is almost entirely informal," stated Bernal. "Workers in any given field generally get to know one another personally, and they arrange among themselves, when they are on friendly terms, the kind of work each of them intends to pursue and the relation of one man's work to another."

The first organized attempt to coordinate aircraft research in the United States was through the Aeronautical Chamber of Commerce, in existence since 1918. In 1940, a technical department was established to represent the industry before government groups. The membership of the Chamber has included most of the major aircraft manufacturers, as well as engine, propeller, and accessory manufacturers.

The coordination activities of the Chamber in 1940 and 1941, as reported by M. Nelles,[V-6] was placed on a voluntary basis as regarded disclosure of research and development data. The scheme which was followed was that companies which had research or test reports which they felt would be of interest to other companies and which they were willing to exchange for reports of approximately equal value, would list the reports with the Chamber. Upon receipt of a coded list, a company would then ask the Chamber to forward its request for certain reports to the lister, after which the barter took place between the two companies.

As the Chamber collected report listings from the aircraft industry, it became increasingly evident that much of the research and testing which had been conducted by airframe manufacturers was pure duplication, hence the possibility existed that, through a cooperative approach, this research could be done more economically for the benefit of the aircraft industry.

M. Nelles,[V-6] Chief of the OPRD Industrial Processes Branch of the War Production Board, has described

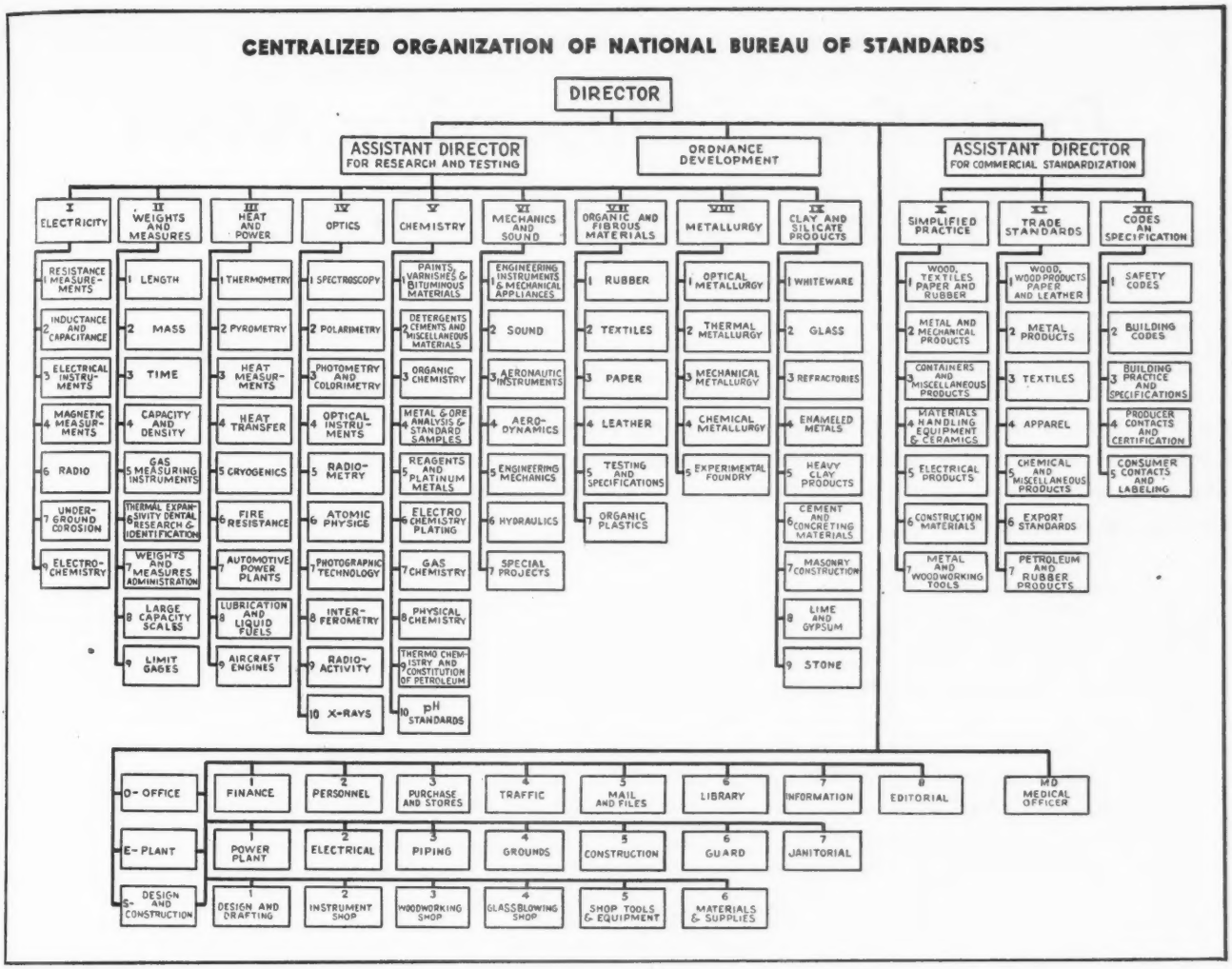


Fig. 3. Laboratory facilities are commonly centralized in government organizations—and on a grand scale. (U.S. Dept. of Commerce illustration)

the coordination of the Aircraft War Production Board activities since 1942 to eliminate duplication, to utilize most effective existing facilities and personnel, and to obtain answers to problems quickly and accurately.

It was in Apr. 1942 that the presidents of the aircraft companies in Southern California met and created the AWPC to facilitate cooperation among member companies to do "more faster with less." One of the chief aims of this arrangement was exchange or loan of materials and parts, for at this time distribution was not operating smoothly. Another aim was exchange of technical data, for it was realized that for some time there would be but one customer—the government.

The Council is a non-profit corporation in which each member company maintains its own identity. Though regional in nature, the West Coast AWPC projects its work nationally through active cooperation with the East Coast AWPC., the Automotive Council for War Production, and the National Aircraft War Production Council.

Nelles, in his complete description of the workings of the West Coast AWPC, explains [V-6] that the presidents of the member companies have directed that ". . . committees shall be free to interchange all information which will help the war production of the company receiving the information, without regard to protection of manufacturing processes which in normal peacetimes might be regarded as secret. This information shall be available not only to Council members but to manufacturers and government agencies outside of the Council in exactly the same manner as the information is interchanged among Council members."

Besides the important coordination of research projects in the aircraft industry by the preparation and circulation of abstract index cards to requestors (to be covered in a later part of this series) and by the sponsorship of a cooperative technical library (Pacific Aeronautical Library, Hollywood, Calif.), the West Coast AWPC has, for two years, arranged interplant visits of research and technical personnel to discuss problems. As Nelles has said, "one of the best results of this cooperation was that specialized personnel in the different plants soon learned to know each other by their first names and were able to discuss their work informally. Once the department heads, division heads, and research engineers found the policy of exchanging information was serious, the exchange took place at an immeasurable rate."

Industry-Government Cooperation in Research

Value of the coordinated research efforts of government, college, and a basic manufacturing industry for a rapid solving of a very serious situation outside of the aircraft industry may be seen in the recent solution of notch sensitivity and fractures on American welded steel merchant vessels. According to an interim report of a Board of Investigation in June 1944,[V-7] fractures have occurred after launching on about 577 occasions to 432 welded ships, up to Apr. 1, 1944, out of a total representative group of

(*Turn to page* 250)

Protection of Magnesium Alloys By New Anodizing Process*

By **N. H. SIMPSON,** *Chief Chemist, and*
P. R. CUTTER, *Research Chemist, Ft. Worth Div., Consolidated Vultee Aircraft Corp.*

Aircraft weight savings are held feasible through expanded use of lightweight metal made possible by a protective coating which not only gives good corrosion resistance but withstands rough handling and service.

MODERN AIRCRAFT DESIGNERS are developing aircraft which a few years ago would have seemed fantastic. Such planes are being made possible because someone worked to create new structural alloys, as of magnesium, whose rigidity, damping effect on vibration and high strength-weight ratio will make its use a must in the skyliners of the future.

Simultaneously with the increase in size of the aircraft being built, the cost goes up. Hence, each plane represents a larger outlay of capital. Investors demand that the capital be protected by long service life.

In order to obtain the life expectancy necessary, resistance of the structural alloys to corrosion must be good. In an airplane, thin sections are used with a minimum factor of safety; hence corrosion, which rapidly destroys the physical properties of metals, is exceedingly dangerous.

Magnesium, in its new expanded use, presented a very difficult problem. How could thin sections, such as .032 and even less, be used without destroying the advantage gained in weight by the amount of protection necessary to withstand corrosion?

Designers were beginning to use this lightweight metal in ever increasing amounts, so the finish-engineers throughout the country were seeking the answer, as were we at the Ft. Worth Div. of Consolidated Vultee Aircraft Corp.

Convair engineers accepted the challenge and immediately started to work, not of necessity to produce a protective coating which possesses a higher initial corrosion resistance but to develop one which could withstand handling and rough service without having to be fortified with too many coats of paint.

Reviewing the literature, it was found that oxide, hydroxide, and carbonate coatings were by far the most resistant to abrasion, while at the same time possessing a fair resistance to corrosion—although not as good in this respect as the sealed chrome pickle or the acid dichromate treated material.

It was also observed that there were three methods of applying the above protective coatings: Autoclaving, heating, and electro-chemical means. Of the three, the electro-chemical was selected as the most likely to be practical for mass production.

Having decided on an electro-chem-

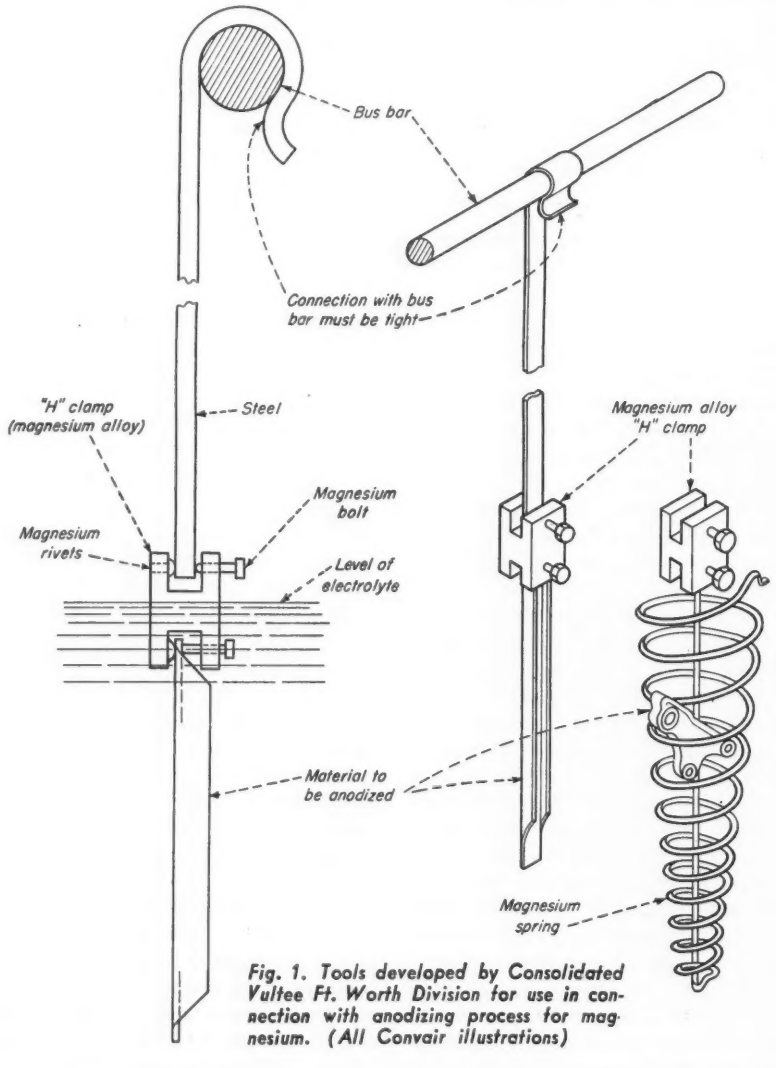


Fig. 1. Tools developed by Consolidated Vultee Ft. Worth Division for use in connection with anodizing process for magnesium. (All Convair illustrations)

*Based on a paper presented before the Magnesium Assn. of America.

ical process, as many possible types of electrolytes as time permitted were tried. From the results of these experiments came the modified alkaline anodic process known as the CVAC No. 1, a.c. or d.c. This anodic process was placed in production at the Ft. Worth Div. with surprising ease and relatively low cost.

Simplicity of the operation was noteworthy. Individuals who had been anodizing aluminum had no difficulty in obtaining good results on the magnesium alloys. It is true that at the beginning some loads were not up to par. However, most of the difficulty was soon traced to the alkaline cleaner and temperature reporter, which were not functioning properly.

The alkaline electrolyte, which consists primarily of caustic soda, seems to last indefinitely. The electrolyte has now been in use for four months without any noticeable change in effectiveness. Then, too, the aggregate cost of the chemicals required to fill a 4,000-gal. tank is $420. Dragout from the tank is low, consequently maintenance of the proper concentration is reasonable (approximately $1 per day).

At present all alloys of magnesium used in the form of sheet, extruded, or forged parts, are being anodized simultaneously. Castings, however, are not mixed with any of the others, but are treated separately. The castings are generally processed at a slightly lower temperature.

Racking of the parts presented some difficulty, which is typical of most electro-chemical processes. However, by adopting H clamps constructed of magnesium (shown in Fig. 1) the trouble was soon overcome. This type of clamp does excellent work and is very durable.

Four tanks are utilized in the CVAC No. 1 process—an unbuffered alkaline cleaner, hot water rinse, anodic tank, and a dilute chromic acid rinse. A hot air dryer is also recommended. After drying, the magnesium alloys are dip-primed immediately. This completely seals the anodic finish and helps to prevent corrosive media from coming in contact with the magnesium during assembly.

If the magnesium were to be used for other purposes (such as household articles, etc.) the dip prime would be left off and a hard wax finish substituted in its place; for such protection is adequate for the purpose and presents a very pleasing finish.

Thousands of tests have been run by Convair's Ft. Worth Div. testing laboratory, and the results have indicated that the all-around protection offered by the CVAC No. 1 process to magnesium alloys is superior to that of any other known practical treatment for the same purpose. This protection, of course, takes into account scratching, abrasion, galvanic corrosion, fretting corrosion, and corrosion in general.

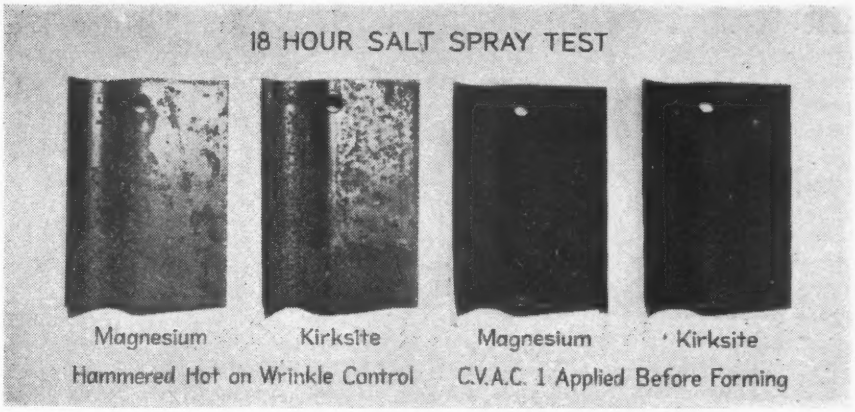


Fig. 2. Protection offered by CVAC No. 1 process (specimens at right) on magnesium alloy during drop hammer forming. Parts were tested in salt spray after forming.

The protective coating produced was found to be harder than the metal itself. This property aids in preventing scratches resulting from the assembly of the magnesium parts and from actual service operations. As the pro-

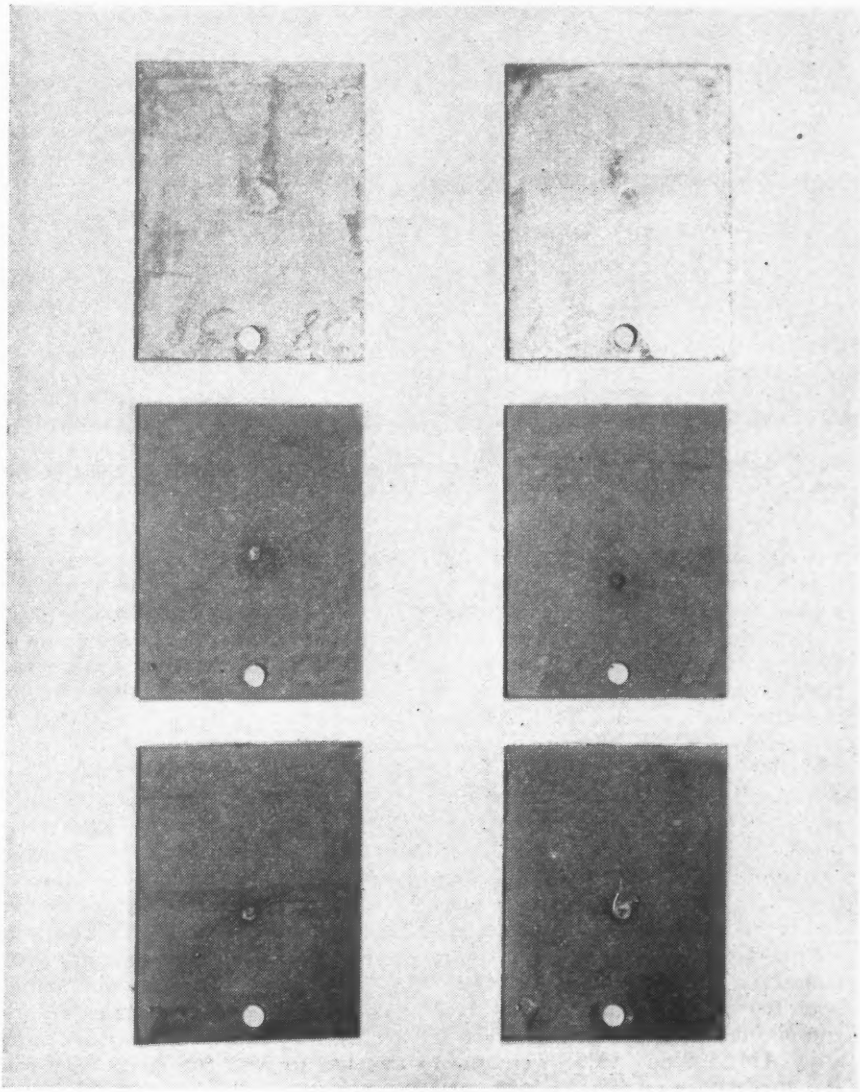


Fig. 3. Showing comparative resistance of acid dichromate and anodized magnesium alloy to blast from explosive rivets, with resistance evaluated by salt spray.

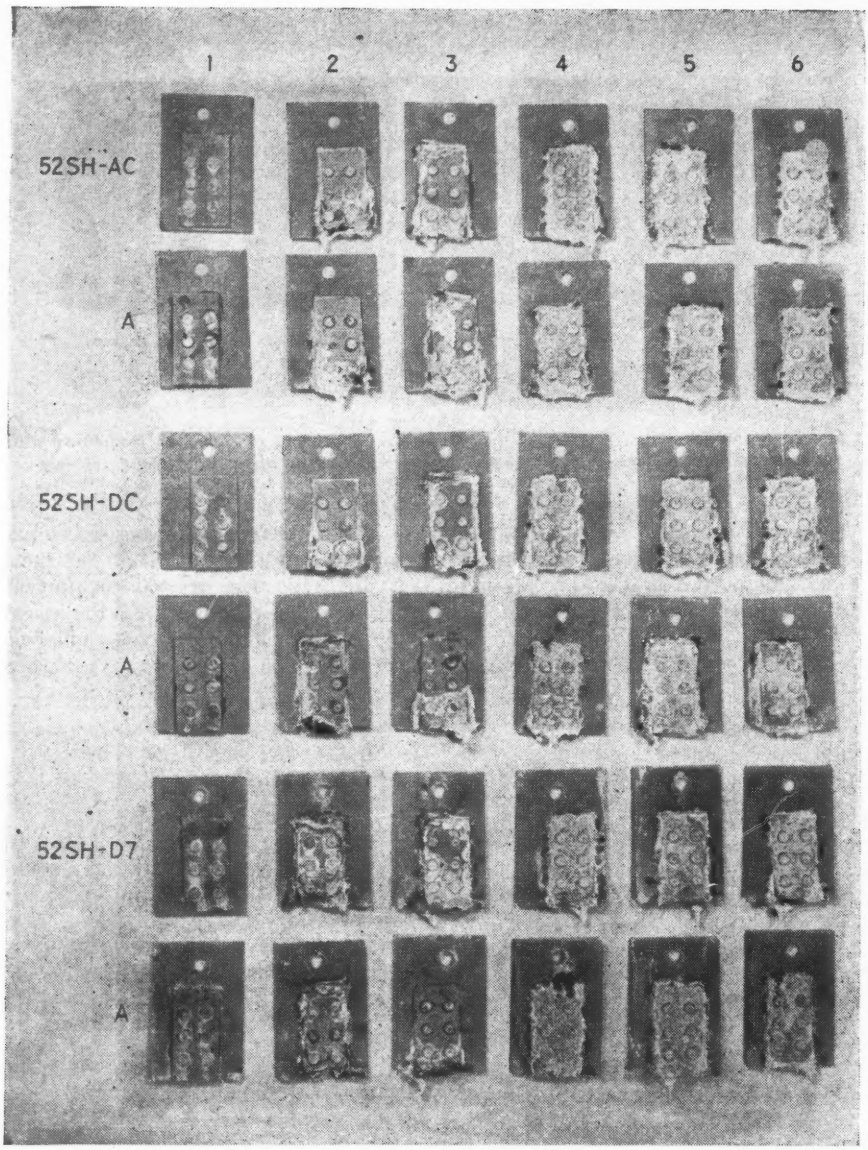


Fig. 4. Comparison of protection offered magnesium alloy against galvanic corrosion by acid and CVAC No. 1 process, using both a.c. and d.c. current.

tective coating was so wear resistant, it was suggested that the coating be applied to the magnesium sheet prior to forming. Tests made to determine the effectiveness of such a procedure gave very gratifying results, proving that the anodic coating protected the magnesium alloys during forming operations, as shown in Fig. 2. Although these tests were successful, such practice has not been put into production.

It is often necessary to heat magnesium alloys during forming operations, and if the CVAC No. 1 anodic process were to be applied prior to forming, it is necessary to know the effect of heat upon the anodic coating. Tests were run in order to determine this effect, if any. AMC52S and AM3S were given the process, using a.c. current, and were heated at various temperatures from room up to 700 deg. F. Other magnesium panels were heated, then given the acid dichromate or chrome pickle treatment. Supplemental coats of primer were applied to some, and all were exposed to a standard salt spray. Conclusion from this testing was that high temperatures up to 700 deg. F. had very little effect upon the corrosion resistance of any of the finishes.

Sometimes during assembly of a plane it is necessary to use blind rivets, a number of which are expanded by an explosive charge. Metallic powder is placed in the shank of the rivet to assure uniform heat distribution prior to firing. The question naturally arose as to the effect of this metallic powder and the force of the explosion on protected magnesium alloys. Du Pont supplied us with 56S rivets filled with magnesium metallic powder.

Plates of magnesium were placed at various distances from the end of the explosive rivet and the rivet fired. Two protective treatments were tried on the magnesium—acid dichromate and CVAC No. 1, a.c. Both treatments were supplemented with one coat of zinc chromate primer. Results of the test are shown in Fig. 3. At $\frac{1}{2}$ in., both the anodic and the dichromate finish failed; however, at 1 in. there was a decided difference.

The acid dichromate finish was still blasted away, leaving the unprotected surfaces exposed to the devastating effect of the salt spray. That was not true of the anodic finish; here, the primer had been blown off, but the anodic coating still remained intact. The result was that the acid dichromate-protected magnesium corroded, while the anodized magnesium did not. Here again the superior hardness of the anodic coating had proved its usefulness.

Parts in reciprocating motion consume power in direct relationship to their mass, which makes magnesium very desirable for use in moving machinery. Sometimes it is necessary that the parts, when in motion, slide over each other. Magnesium would be aided in this situation by the relatively hard CVAC No. 1 anodic coating, especially since its coefficient of friction is low in comparison with chrome pickle or acid dichromate finishes.

As magnesium is the least noble of all structural alloys, it always suffers when in contact with dissimilar metal if not adequately protected, presenting the worst problem with which the finish-engineer has to cope. Generally when magnesium is used, it must come in contact with a dissimilar metal. Therefore, the more extensive its use, the greater the variety of metals from which it must be insulated.

There is no known commercial treatment which will entirely protect magnesium from galvanic corrosion under all conditions. The different protective coatings simply vary in the degree to which they will retard this type of corrosion.

An anodic coating such as CVAC No. 1 is inherently a good dielectric. As galvanic corrosion is caused by a battery-like action which is set up between the dissimilar metals in the presence of moisture, it seemed reasonable to believe that the anodic coating would aid in retarding this particular type of corrosion. Tests which were run by ATSC at Wright Field, and Convair at Downey, Calif., supported this contention. It should be noted that in all cases, whether the chemical treatments were applied by the ATSC or another laboratory, the galvanic corrosion resistance of the anodic coat-

ing was discovered to be superior.

This, of course, does not completely solve our problem, but it does indicate a step in the right direction. If there were any doubts as to the difference between corrosion resistance of magnesium assemblies when in contact and when not in contact with a dissimilar metal, Fig. 4 gives evidence to correct this.

The large panels in each case are composed of AMC52S-H. The smaller attachment panels are: Vertical row, No. 1, AMC52SH; No. 2, clad 24ST; No. 3, anodized 24ST; No. 4, cadmium plated X-4130; No. 5, zinc plated X-4130; and No. 6, stainless steel. All panels were assembled with 56S rivets and given a regular paint treatment. It is relatively easy to protect the magnesium from corrosion when not in dissimilar metal contact, as shown by the results in the vertical column No. 1; but notice from there on that corrosion is rampant.

However, close study of the specimen reveals that the anodic coating is once more aiding in retarding galvanic corrosion. This is especially noticeable where the attached metals are not too far removed from the magnesium in the electromotive series. From this test we also find that the ratio of the cathode to the anode is rather high. This is an extremely undesirable situation to have and, of course, is avoided as much as possible in actual practice. Nevertheless galvanic corrosion is still a very important problem and one with which the aircraft industry is vitally concerned.

Often it is necessary to completely assemble parts prior to applying a protective treatment; for example, if spotwelding were to be used. Then the question naturally arises as to the ability of the protective treatment to penetrate the lap joints, etc., in order to effectively protect the part from corrosion.

As spotweld tests were being run on magnesium it was decided to try protecting some spotweld test specimens by the acid dichromate, chrome pickle, and anodic treatment. After the three treatments had been applied, the specimens were pried apart for studying, with results as shown in Fig. 5. There is no doubt that the anodic treatment, while not perfect by any means, does penetrate further and more uniformly than the chemical treatments.

Spotweld specimens, protected as previously mentioned, were placed in the salt spray and checked for corrosion. As the earlier test indicated, the chemical treatments did not afford as much protection at the lap joints as did the anodic.

The corrosion resistance of magnesium alloys, not subject to mechanical injury or in contact with dissimilar metals, has not been materially increased by the CVAC No. 1 process, since separate laboratory tests have listed the acid dichromate and the process, a.c. or d.c., as equal in their ability to withstand accelerated corrosion, such as 20 percent salt spray, when unprimed. However, the reports indicate a slight superiority of the anodic treatment when primed.

One report coming from another laboratory listed the CVAC No. 1 process as being inferior to the acid dichromate in corrosion resistance and paint adherence. Checking back on other specimens prepared at the same time, it was found that the zinc chromate primer was of poor quality and absorbed moisture readily. It is believed that this was the cause of the poor showing reported by this one laboratory. However, on the basis of this one unfavorable report, an intensive testing program is underway to investigate all factors which might again produce such results.

Accelerated weathering tests run by Convair both at Downey and Ft. Worth, in a National Carbide accelerated weathering unit, operated without filters, using No. 13 and 22 copper coated sunshine electrodes, did not reveal any startling difference between the ability of any of the finishes to withstand this type of test. There were some failures, but none which would lead one to expect much better protection from one finish than the other. This test was discontinued after 1,880 hr. It is noted that 1 hr. in the accelerated weathering unit is approximately equal to 24 hr. weathering; thus the specimens were actually exposed the equivalent of 5 yr. to normal weathering.

Although this discussion has centered mainly around airplanes, the same considerations apply to all other fields such as furniture, vacuum cleaners, chandeliers, baby carriages, decorative works, blackboards, toys, and a multitude of others.

As it is possible to produce highly colored coatings with the CVAC No. 1 protective treatment, there should be a great demand for it in postwar days. It is possible that a multitude of common articles which are destined to be made from magnesium in the postwar era will be brightened and made gayer by the application of this process, whose primary purpose was to build better airplanes.

Convair realizes that accelerated weathering and corrosion tests may not nearly approximate the service life of any protective coating and only serves as an indication. For this reason, extensive outdoor tests are being made by ATSC at Wright Field and Convair at Downey, Calif., and Fort Worth, the results of which should be made known within a few months.

Convair's Ft. Worth Div. weathering rack is located upon the roof of the main building, where combinations of coatings on magnesium alloys are undergoing natural weathering tests. It is hoped that from the results of these tests, and thousands of similar tests throughout the world, continuous improvement can be made in the quality of the present protective coatings, thus bringing everyone closer to the ultimate goal—perfect protection in all kinds of corrosive environments for magnesium and its alloys.

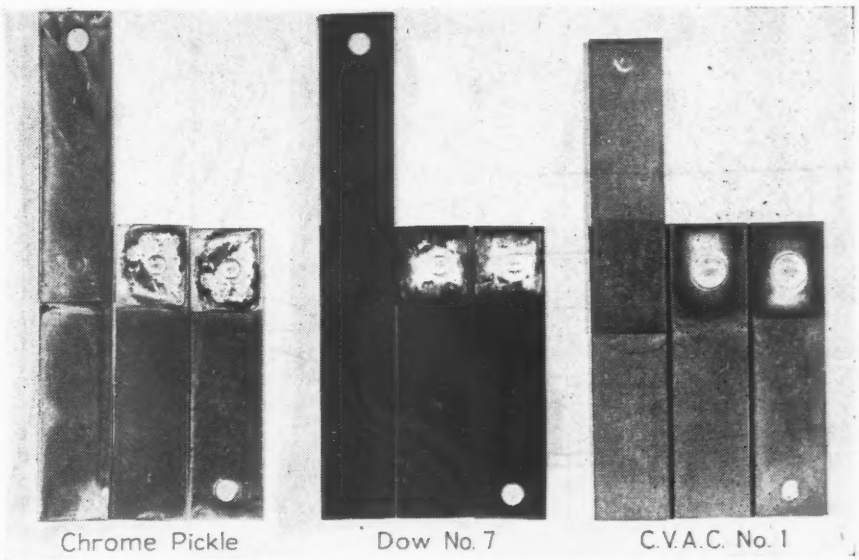


Fig. 5. Spotwelded magnesium treated by chrome pickle (left), acid dichromate (center), and CVAC No. 1 process (right), with strips pried apart to show penetration of protective treatment between lapped joints.

IS AIRPLANE STABILITY SUCH A MYSTERY?

PART II

By **GEORGE H. TWENEY,** *Consulting Aeronautical Engineer*

Continuing his concise treatment of the derivation of formulas for stability forces and moments, the author presents an analysis of yawing moment due to sideslip, damping in roll and yaw, and other pertinent aerodynamic factors . . . Conclusion of two-part article.

TO BETTER UNDERSTAND the l_v derivation (considered at the conclusion of Part I, Mar. AVIATION), it would be helpful to review the theory on the effects of dihedral angle, as presented in any of the basic books on aerodynamics—for example, the treatment on page 211 of *Engineering Aerodynamics* by Walter S. Diehl (revised edition, 1936).

The value l_v is due primarily to dihedral, and in the derivation, γ is the dihedral angle in radians, S_d is the area of that part of the wing having the dihedral, and $\xi = (k_A/l)^2$ where k_A is again the radius of gyration of the airplane about the suitable axis.

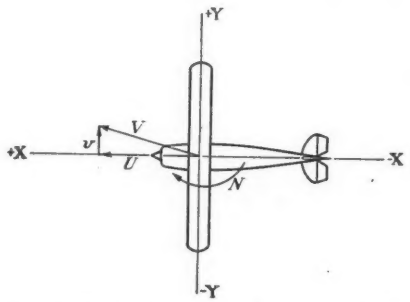


Fig. 6. Derivation of yawing moment due to sideslip.

The value n_v, the yawing moment due to sideslip, can be obtained from the slope of the ordinary yawing moment curve of a wind tunnel test, using the same procedure as for l_v. Referring to Fig. 6:

$$\text{Yawing moment } N = \frac{dN}{d\psi} + \Delta\psi$$

$$= -\left(\frac{dC_N}{d\psi}\right) \times \Delta\psi \times \left(\frac{\rho}{2} V^2 Sb\right)$$

$$\Delta\psi = \arctan \frac{v}{U} = \frac{v}{V}$$

$$\therefore N = -\left(\frac{dC_N}{d\psi}\right) \times \frac{v}{V} \times \frac{\rho}{2} V^2 Sb$$

$$\therefore \frac{dN}{dv} = -\left(\frac{dC_N}{d\psi}\right) \times \left(\frac{\rho}{2} VSb\right)$$

$$\therefore n_v = \frac{-\frac{dN}{d\psi}}{\rho S V l \zeta}$$

$$= \frac{-\left(\frac{dC_N}{d\psi}\right) \times \frac{\rho}{2} VSb}{\rho S V l \zeta}$$

$$= -\frac{b}{2l\zeta}\left(\frac{dC_N}{d\psi}\right)$$

In this equation, $\zeta = (k_c/l)^2$ and k_c is the radius of gyration of the airplane about the remaining reference axis.

The value l_p is the damping in roll, and may be obtained from the rolling moment due to rolling. A simplified version of the derivative may be obtained by using the moment due to the lift alone. This, then, applies only to small changes of angle of attack. Reference to Fig. 7 gives the following:

$$\Delta\alpha = \arctan \frac{py}{V} = \frac{py}{V}$$

$$\Delta L = -\left(\frac{dC_L}{d\alpha}\right) \times \frac{py}{V} \times \frac{\rho}{2} V^2 c\, dy$$

$$\Delta L' = y \times \Delta L$$

$$= -\left(\frac{dC_L}{d\alpha}\right) \times \frac{py^2}{V} \times \frac{\rho}{2} V^2 c\, dy$$

$$\therefore L' = -\left(\frac{dC_L}{d\alpha}\right) pVc\frac{\rho}{2} \int_{-\frac{b}{2}}^{\frac{b}{2}} y^2\, dy$$

$$= -\left(\frac{dC_L}{d\alpha}\right) p\, V\, c\, \frac{\rho}{2}\left[\frac{y^3}{3}\right]_{-\frac{b}{2}}^{\frac{b}{2}}$$

$$= -\left(\frac{dC_L}{d\alpha}\right) p\, V\, c\, \frac{\rho}{2}\left(\frac{b^3}{24} + \frac{b^3}{24}\right)$$

$$= -\left(\frac{dC_L}{d\alpha}\right) p\, V\, c\, \rho\, \frac{b^3}{24}$$

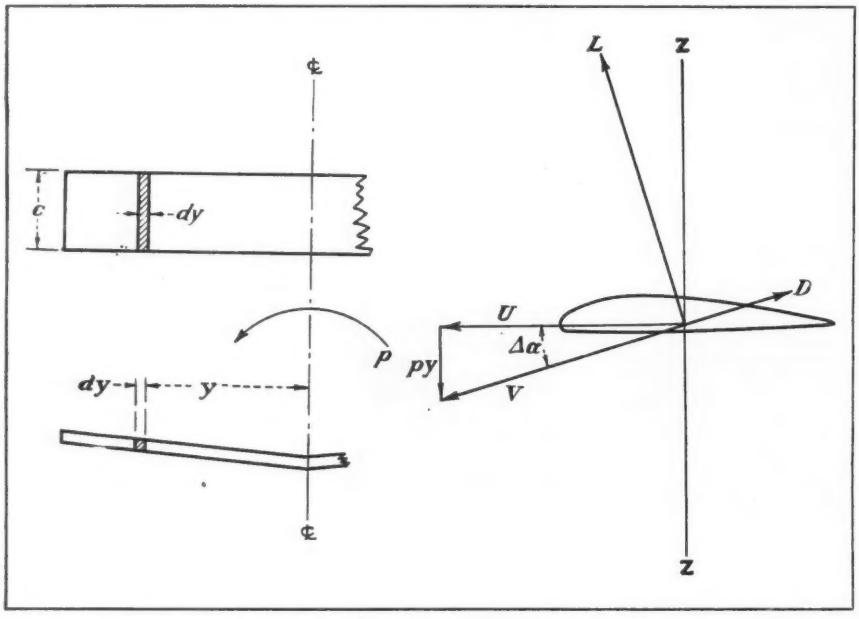


Fig. 7. Derivation of damping in roll, l_p.

Then,

$$\frac{dL'}{dp} = -\left(\frac{dC_L}{d\alpha}\right)\frac{V\,c\,\rho\,b^3}{24}$$

$$\therefore lp = -\left(\frac{dC_L}{d\alpha}\right)\frac{V\,c\,\rho\,b^3}{24\,\rho\,V\,S\,l^2\,\xi}$$

$$= -\left(\frac{dC_L}{d\alpha}\right)\times\left(\frac{b}{l}\right)^2\times\frac{1}{24\xi}$$

The comment was made that the above equation refers to small changes in angle of attack only. If the derivation were made to include the moment due to the drag as well as that due to the lift, the following would result:

$$lp = \frac{1}{24\xi}\left(\frac{b}{l}\right)^2\times\left(C_D + \frac{dC_L}{d\alpha}\right)$$

Comparison of these two expressions for l_p shows that they differ only by the C_D term.

The value n_p is due almost entirely to the yawing moment which results from the change in lift direction and induced drag along the span, and is obtained from the yawing moment due to rolling. It is difficult, although possible, to measure it in wind tunnel tests, but the calculated values are easier to obtain, and are preferable. Reference to Fig. 7 will also serve for the derivation of this derivative.

Thus:

$$\Delta\alpha = \text{arc tan}\,\frac{py}{V} = \frac{py}{V}$$

$$\Delta X = L\sin\alpha - D\cos\alpha$$

$$= L\frac{py}{V} - D \text{ since the angles are small.}$$

Then:

$$\Delta N = -y\left[C_L\frac{py}{V} - \left(\frac{dC_D}{d\alpha}\right)\frac{py}{V}\right]\frac{\rho}{2}V^2S$$

$$= -\left[C_L py^2 - \left(\frac{dC_D}{d\alpha}\right)py^2\right]\frac{\rho}{2}VS$$

$$\therefore N = -\frac{\rho}{2}Vc\times$$

$$\int_{-\frac{b}{2}}^{\frac{b}{2}}\left[C_L\,p\,y^2 - \left(\frac{d\,C_D}{d\alpha}\right)py^2\right]dy$$

This expression is the basic value of the integration of the moment of the lift component and the change in induced drag along the span.

$$\therefore N = -\frac{\rho}{2}Vc\left[C_L\frac{py^3}{3} - \left(\frac{d\,C_D}{d\alpha}\right)\frac{py^3}{3}\right]_{-\frac{b}{2}}^{\frac{b}{2}}$$

$$= \frac{\rho}{2}V\,c\,p\left[\left(\frac{d\,C_D}{d\alpha}\right)\frac{b^3}{12} - C_L\frac{b^3}{12}\right]$$

$$\therefore \frac{dN}{dp} = \frac{\rho}{2}V\,c\left[\left(\frac{d\,C_D}{d\alpha}\right)\frac{b^3}{12} - C_L\frac{b^3}{12}\right]$$

Then, as before:

$$n_p = \frac{\frac{\rho}{2}Vc\left[\left(\frac{dC_D}{d\alpha}\right)\frac{b^3}{12} - C_L\frac{b^3}{12}\right]}{\rho S V l^2\xi}$$

$$= \left[\left(\frac{dC_D}{d\alpha} - C_L\right)\right]\left(\frac{b}{l}\right)^2\frac{1.}{24\xi}$$

Since the increase in drag is due to the induced drag, and since $\Delta\alpha$ is small, from

$$C_{D_i} = \frac{C_L^2}{\pi A_e}$$

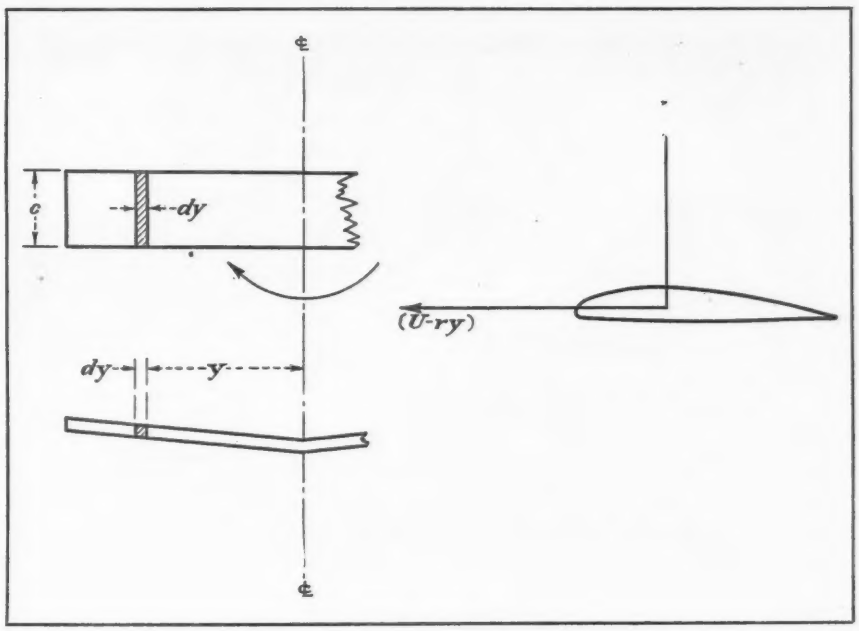


Fig. 8. Derivation of rolling moment due to yawing.

$$\therefore \frac{dC_{D_i}}{d\alpha} = \frac{2\,C_L}{\pi\,A_e}\left(\frac{dC_L}{d\alpha}\right)$$

Substituting this in the equation above,

$$\therefore n_p = \frac{C_L\,b^2}{12\,\xi\,l^2}\left[\left(\frac{dC_D}{d\alpha}\right) - \frac{1}{2}\right]$$

In this development, ξ is again a factor for the radius of gyration of the airplane about the proper axis. A_e is the effective aspect ratio in this calculation.

The value of l_r depends on the change in velocity along the span, and can be calculated from the rolling moment due to yawing. Thus, referring to Fig. 8, at the element dy,

Velocity $= (U - ry)$

(*Turn to page* 244)

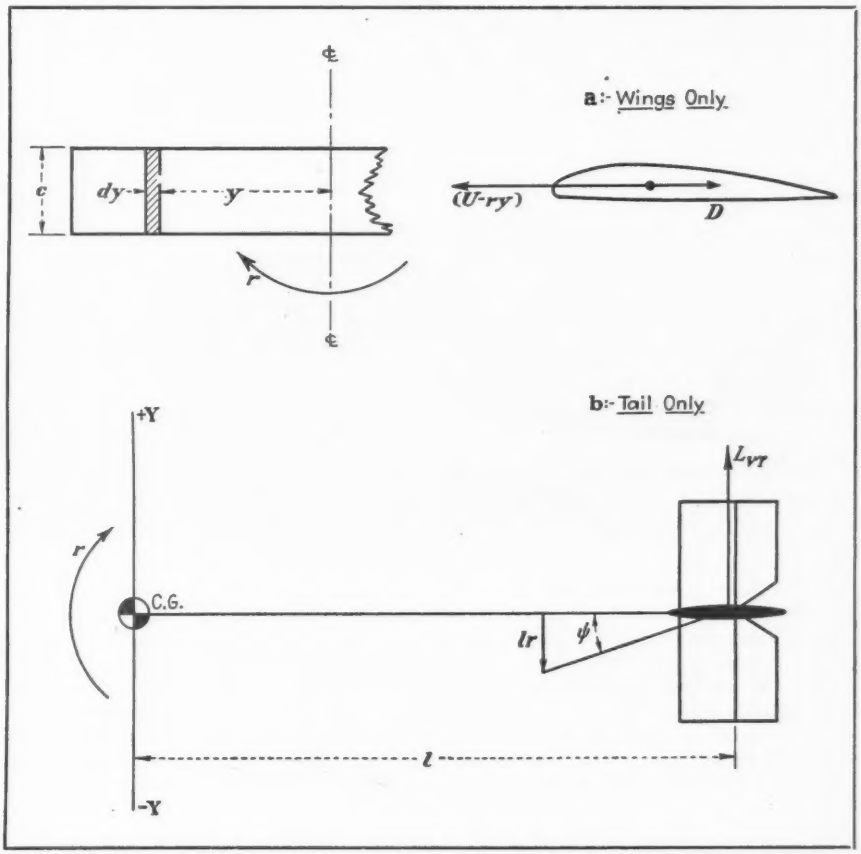


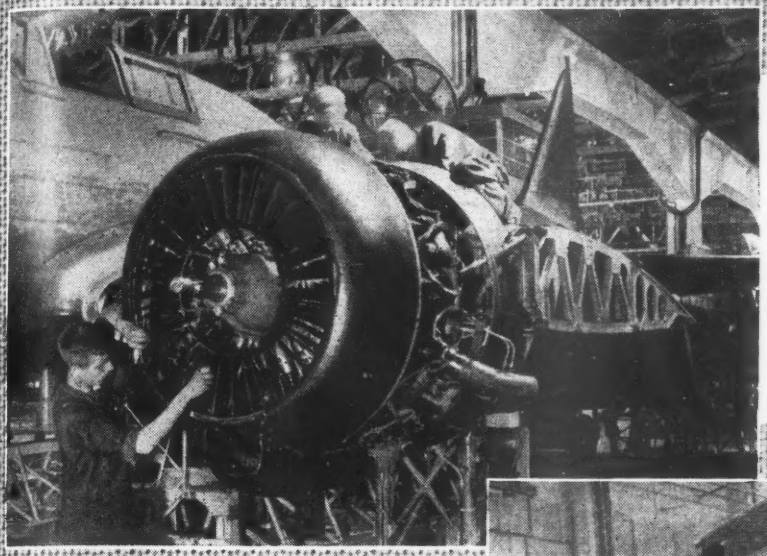
Fig. 9. Derivation of yawing moment due to yawing.

Stormavik IL-2's in final assembly stage. In this section of a large, unidentified Soviet factory, planes are having outer wing panels attached. No continuous conveyor lines are in evidence. As will be noted in right foreground, dollies are employed to move wing sections into position for attachment. (Sovfotos)

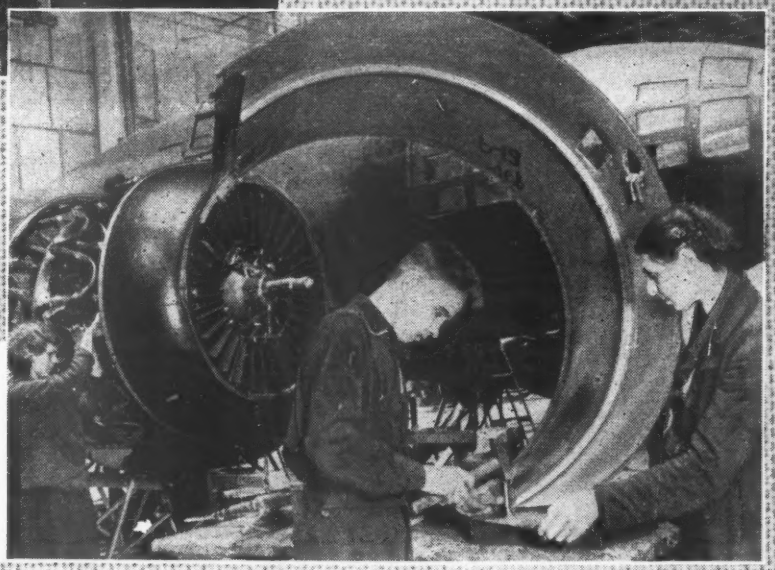
A PHOTO VISIT IN SOVIET WARPLANE PLANTS

Just released, these photos show details of the Russian production lines that supplied the Red Air Forces with planes, first to grind down the "blitz", then to pace the assault into Germany.

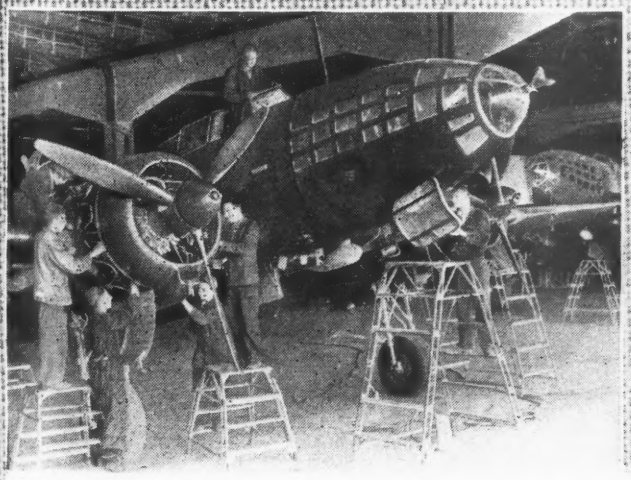
Above: Completed Stormaviks awaiting flyaway delivery. Designed for low level attack missions in support of infantry, these planes are heavily armed with rockets, cannon, and machine guns. Power plant is in-line Toupolev M-38 of 1,300 hp., and top speed is about 280 mph. Early Stormaviks were single seaters, whereas these later models are two-place, with rear gunner handling twin flexible guns. Note large diameter tube projecting from leading edge of wing near fuselage; unidentified, it may be new type of armament. Right: Control units for IL-4 bombers being assembled on trolley conveyers. Frame on which unit is set is mounted on casters and shuttled along for individual operations. In center of moving frame is track lock to keep work steady. At right, control column can be seen in place. Chief of assembly conveyor (left) inspects part of a unit. Evidence of Soviet's total war mobilization is shown in youth of workers. In war's early stages some plants actually underwent German's artillery fire and, after shifts, workers fought in trenches.



Engine being installed on IL-4 is 14-cyl. M-88 twin-row radial of 1,100 hp., fitted with controllable shutters, as used for cold weather operations. Wing at center section appears to be of two-spar truss-rib construction, with four attachment points for outer wings. Split trailing edge flaps are in extended position. Exhaust gas analyzer can be seen attached to engine manifold. Odd feature for a modern combat plane is externally fixed handhold on fuselage near pilot's cockpit.



IL-4's engine cowling, which is built in two halves, gets some adjustments before installation. Component details on Soviet airplanes appear to be kept to a minimum, with ease of maintenance and ruggedness stressed.



Above: End of a production line, with IL-4's receiving final touches before being tested. Hinged, transparent hatch is probably used as exit door by forward gunner and bombardier. Featured here are portable work stands, apparently of standardized design in various sizes, of which some may be fitted with casters. Right: Soviet IL-4, formerly known as DB-3F, is a long-range high-performance bomber with a top speed of over 265 mph. Normal range is 2,500 mi., and gross wt., 33,000 lb. Construction is all-metal, mostly flush-riveted. Retractable landing gear appears to have been developed from type used in Douglas DC-3's, many of which are being used by Russia's air force. Rear upper turret is power-operated, and a retractable belly turret is also incorporated in the craft.

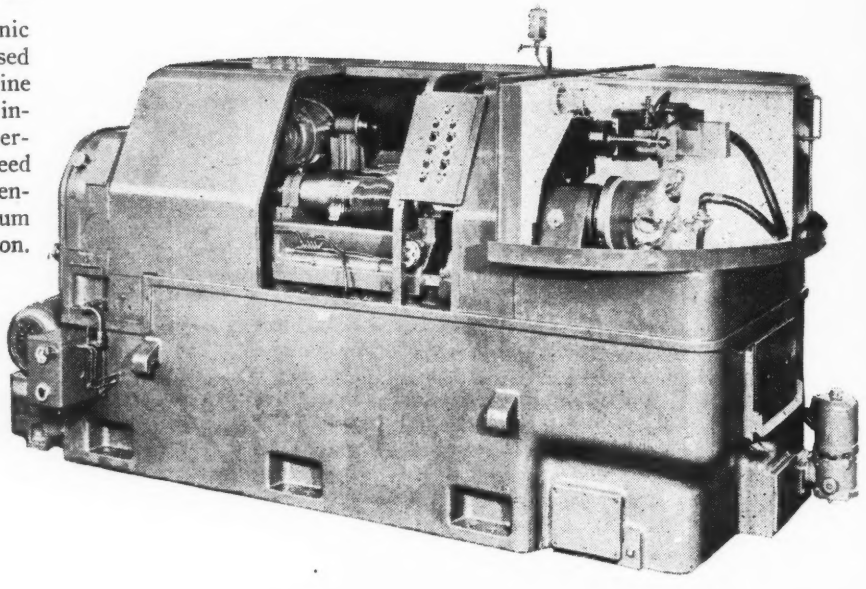
PLANT-PRACTICE HIGHLIGHTS

Simple Inspection Gage Eliminates Protractor

• Eyestrain and frequent adjustments are stated to be avoided by use of gages invented by Henry Benson, of Northrop's sheet metal department, and as a result one hour of inspection time is reported saved in every eight. Gage plates are made in two sets, one for angles greater than 90 deg. and the other for lesser angles. Photos show gages in use.

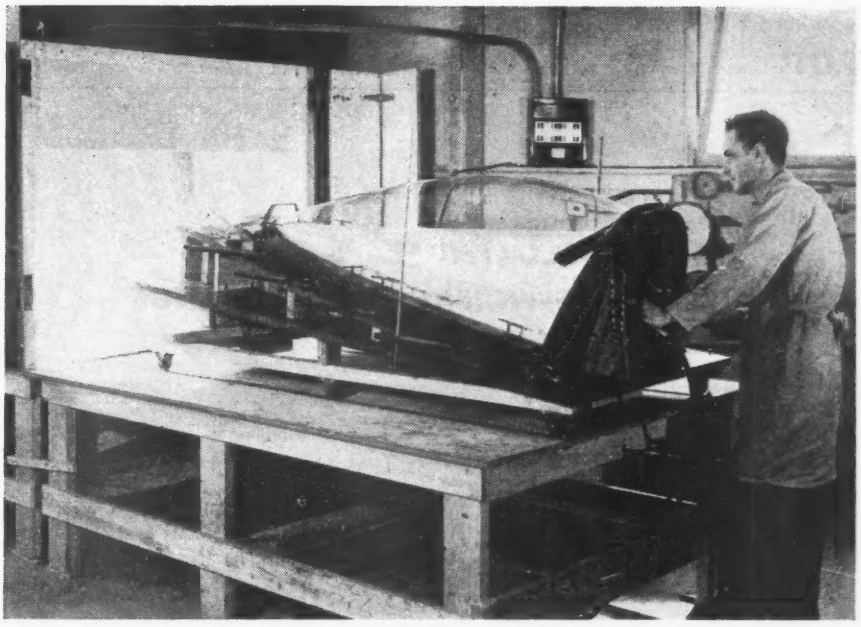
Electronic Speed Control Increases Cylinder Head Output

• Westinghouse Mototrol electronic speed control of milling machines used for cutting cooling fins on engine cylinder heads is stated to have increased production as much as 30 percent by automatically varying feed according to depth of cut, thereby enabling cutter to perform at maximum efficiency throughout entire operation.



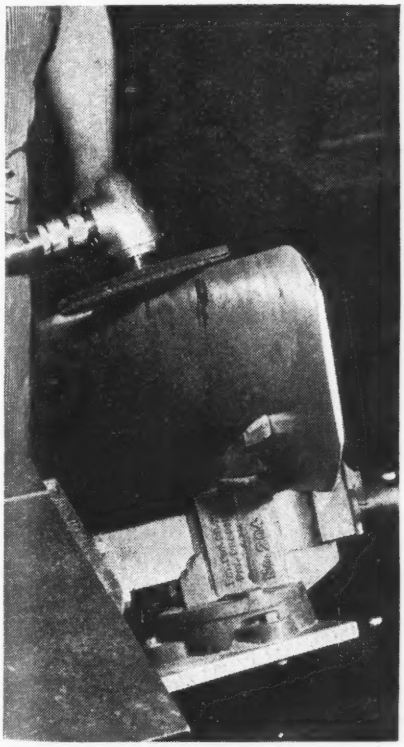
Transparent Tubes Protect Stored Blueprints

• Rolled blueprints are protected from dust and damage by storing in Eastman Tenite tubes with numbered wooden stoppers, enabling rapid identification of any desired sheet. Simplified filing system eliminates need for any technical knowledge of contents when replacing tubes in pigeonholes.



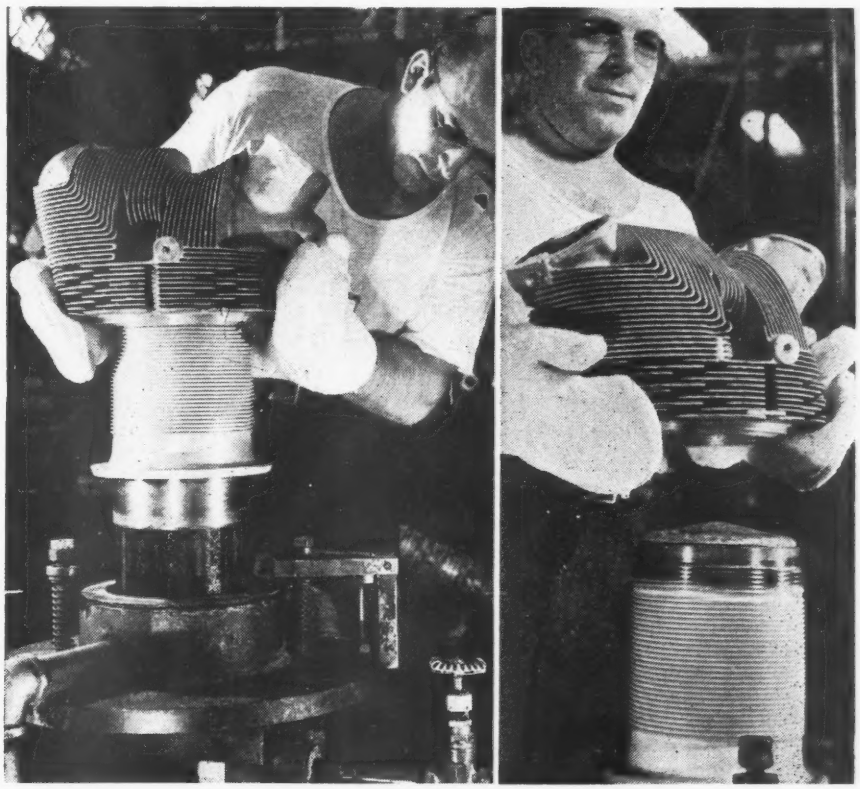
Free Blowing Method Forms Plastic Cockpit Covers

• Using heat modulation and pressure control, Stack Plastics has developed free blowing method for shaping one-piece cockpit covers for fighter planes. Patented process forms compound curves without surface being touched, consequently working blemishes are said to be unknown.



This New Swivel Vise Eliminates Safety Hazard

• By using a swivel vise bolted to front of grinding bench, Floyd Drumm of Hamilton Standard not only combines two operations but also prevents safety hazard formerly present when it was necessary to move propeller blades by hand after first part of work was completed.



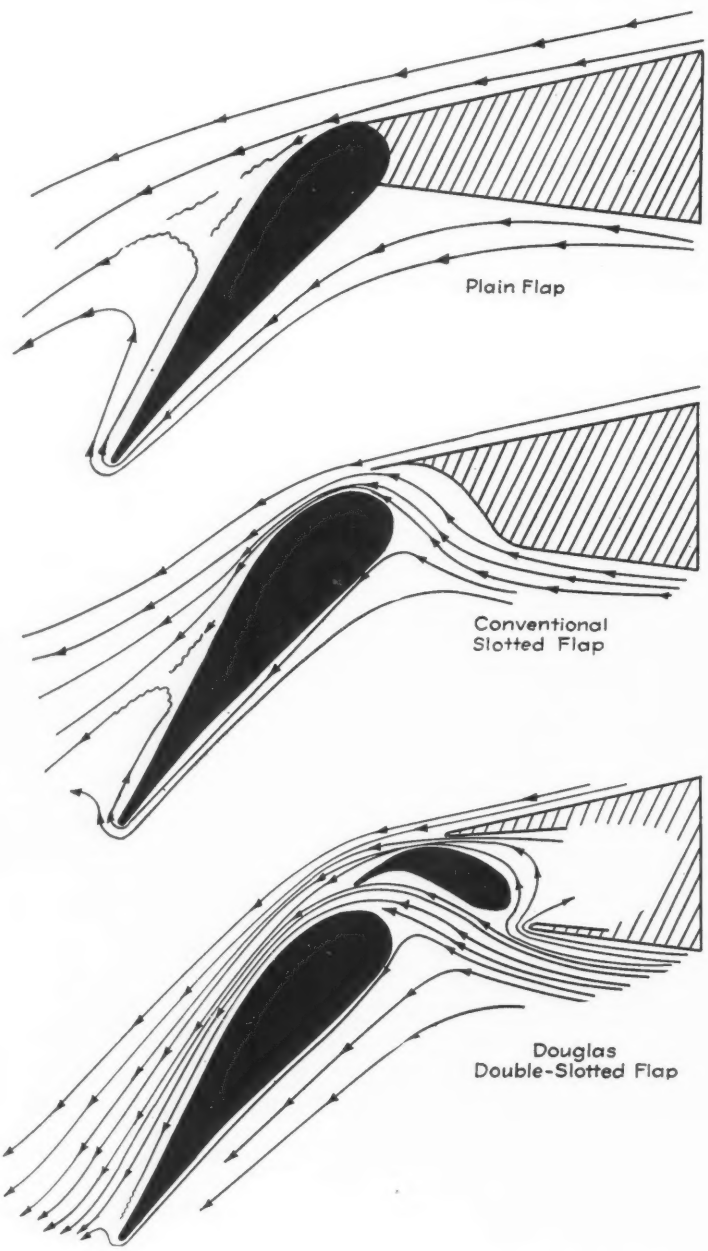
Cooler Assists Cylinder Head Removal

• For removing cylinder heads—shrink and screwed together—Curtiss-Wright's Lockland plant use water-cooled center stud over which heated engine cylinder is placed. Cylinder shrinks rapidly, before head loses its heat, thereby enabling worker to separate them. Left illustration shows operator using asbestos gloves to place heated cylinder over cooling unit, while right photo demonstrates ease with which head may be unscrewed from cooled cylinder, firmly shrunk onto center stud.

FOR BETTER DESIGN

DOUBLE-SLOTTED FLAPS ON A-26 GIVE HIGH-EFFICIENCY PERFORMANCE

By **C. R. PETTIT** *Administrative Engineer, Douglas Aircraft Co.*



Graphic representation of test results depicting airflow over various types of flaps set at 52 deg. Note complete separation over plain flap, partial separation over conventional slotted flap, and reduced separation with Douglas double-slotted flap.

MANY FACTORS contribute to the superiority of the Douglas A-26 Invader over its predecessor, the A-20, but none is more outstanding than the new double-slotted wing flaps. Without increasing flap weight, these units permit performance factors which, as a matter of fact, are seemingly at variance with aerodynamic data.

To meet the increasing demand for higher speeds, it has been necessary to proportionately reduce wing area, thereby increasing wing loadings. The resulting increase in takeoff and landing speeds and longer runway requirements conflict sharply with combat zone realities of small and none-too-smooth fields. To reconcile these performance factors in the design of the A-26 with war-theater conditions, the development of a more effective landing flap was undertaken.

Tests were conducted on a large scale model of the wing in Cal Tech's 10-ft. wind tunnel, and a number of positions of the flap and vane (affording a double slot) were investigated until an optimum location was determined which gave remarkably high values of lift.

Results of the tests are illustrated in the accompanying sketch showing airflow over various types of flaps set at an angle of 52 deg. With the plain flap, the airflow lines indicate an almost completely stalled condition. The flow has separated from the upper surface of the flap and is very turbulent, representing almost complete loss of lift. With the conventional slotted flap, the amount of separated flow is reduced. And with the Douglas double-slotted flap, flow separation is practically eliminated. This type can be set at higher flap angles than the other two without encountering separation, and therefore its lift is proportionately greater.

A second wind tunnel model, built to check and verify the previous findings, was tested at the NACA laboratory at Langley Field, where nearly full-scale conditions could be duplicated. The result of this development program is the new Douglas double-slotted flap, credited with the following advantages:

(1) For a given wing area, lower landing speed is possible, hence landings are correspondingly safer.

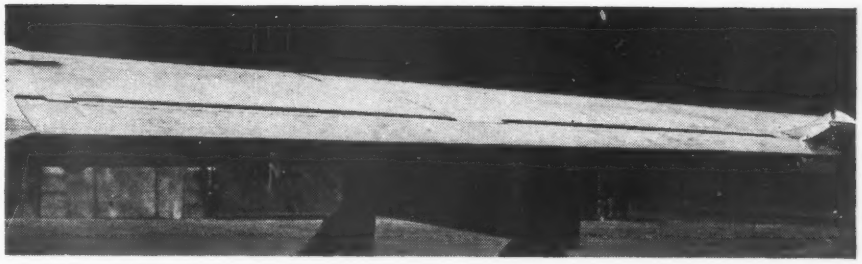
(2) Relatively high drag of the

flap contributes to the braking during landing roll. The A-20, with a normal weight of 18,600 lb. has a landing distance of 2,560 ft., whereas the A-26 with normal weight of 27,600 lb. requires but 2,400 ft.

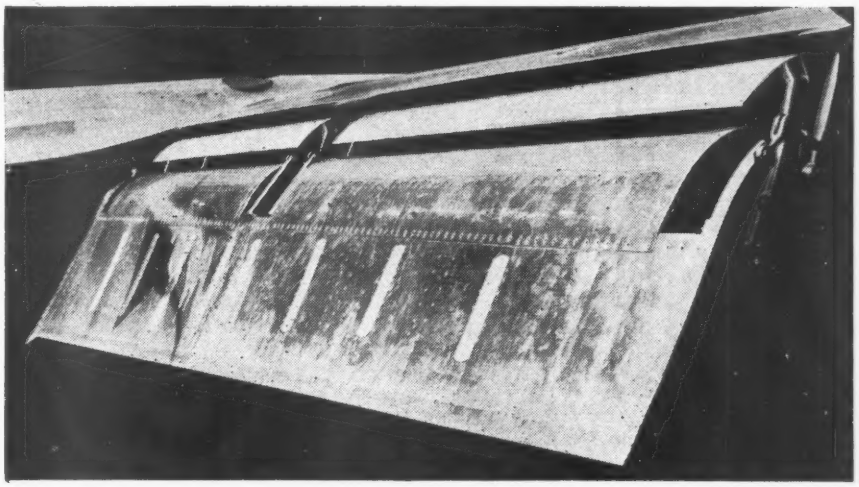
(3) The glide path is rather steep, thus permitting the use of comparatively short landing fields having relatively high boundary obstructions, and with flaps fully extended, the plane comes in somewhat nose down, rather than nose up (as is usually the case) considerably improving pilot's visibility.

(4) The flaps give substantial improvement in takeoff distance requirements. The A-20, when operating in an overload condition of 26,000 lb. and with a consequent wing loading of 56 lb., requires 3,100 ft. for takeoff, whereas the A-26 with an overload condition of 35,000 lb. and a wing loading of 65 lb. takes off in 3,450 ft.

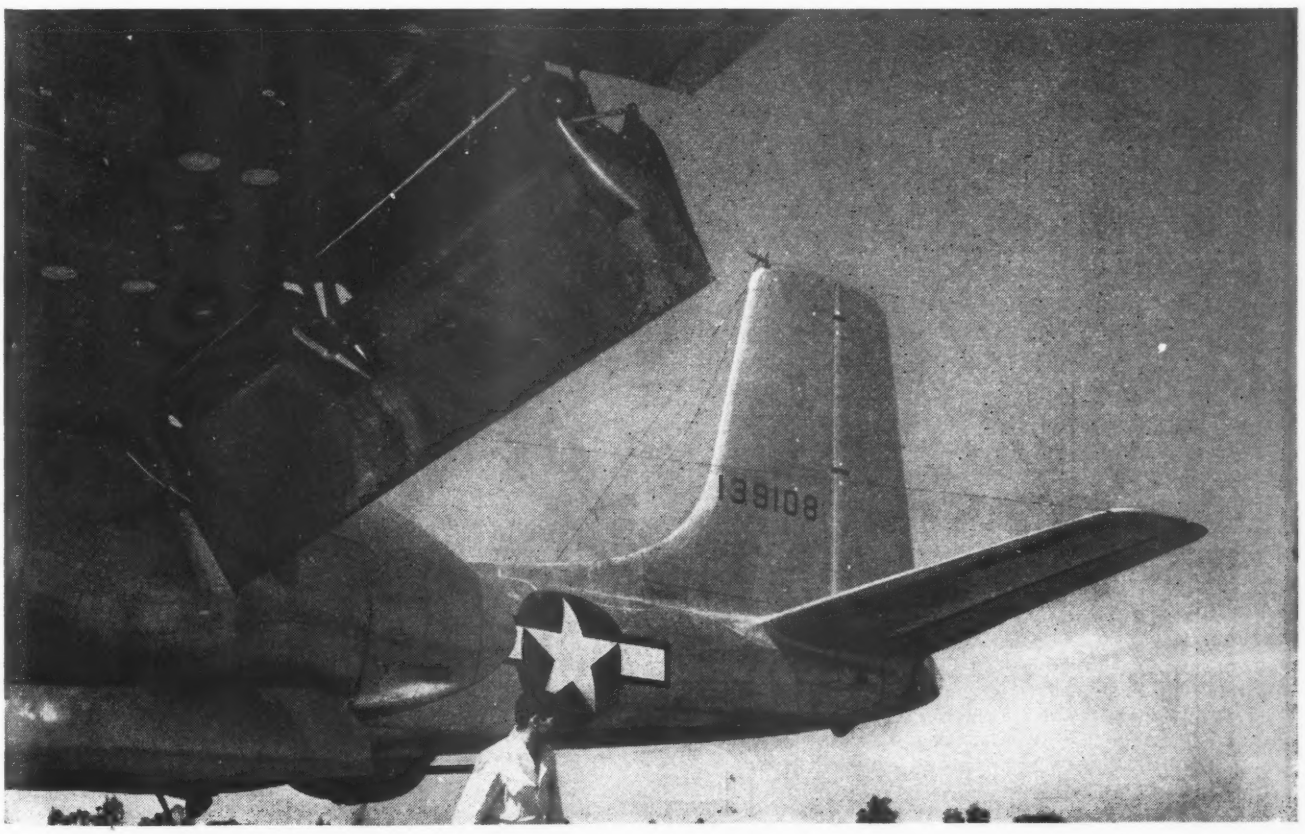
The flaps are supported on four-bar linkage, retractable within the wing contour, thus maintaining aerodynamic cleanliness. The vane is also supported on this linkage and moves with respect to the flap to remain in optimum position for all degrees of flap travel. Electrically operated, the flaps are interconnected in a manner to assure symmetrical deflection.



In retracted position of flap, linkage is completely contained within the wing contour, providing aerodynamic cleanliness.



Double-slotted flap in extended position. Vane is at top and moves with respect to flap so as to maintain optimum position for all degrees of flap travel.



This underwing shot of Douglas A-26 Invader shows bottomside of vane and its relative position between wing trailing edge and flap proper. Note fairing for linkage when flap is retracted

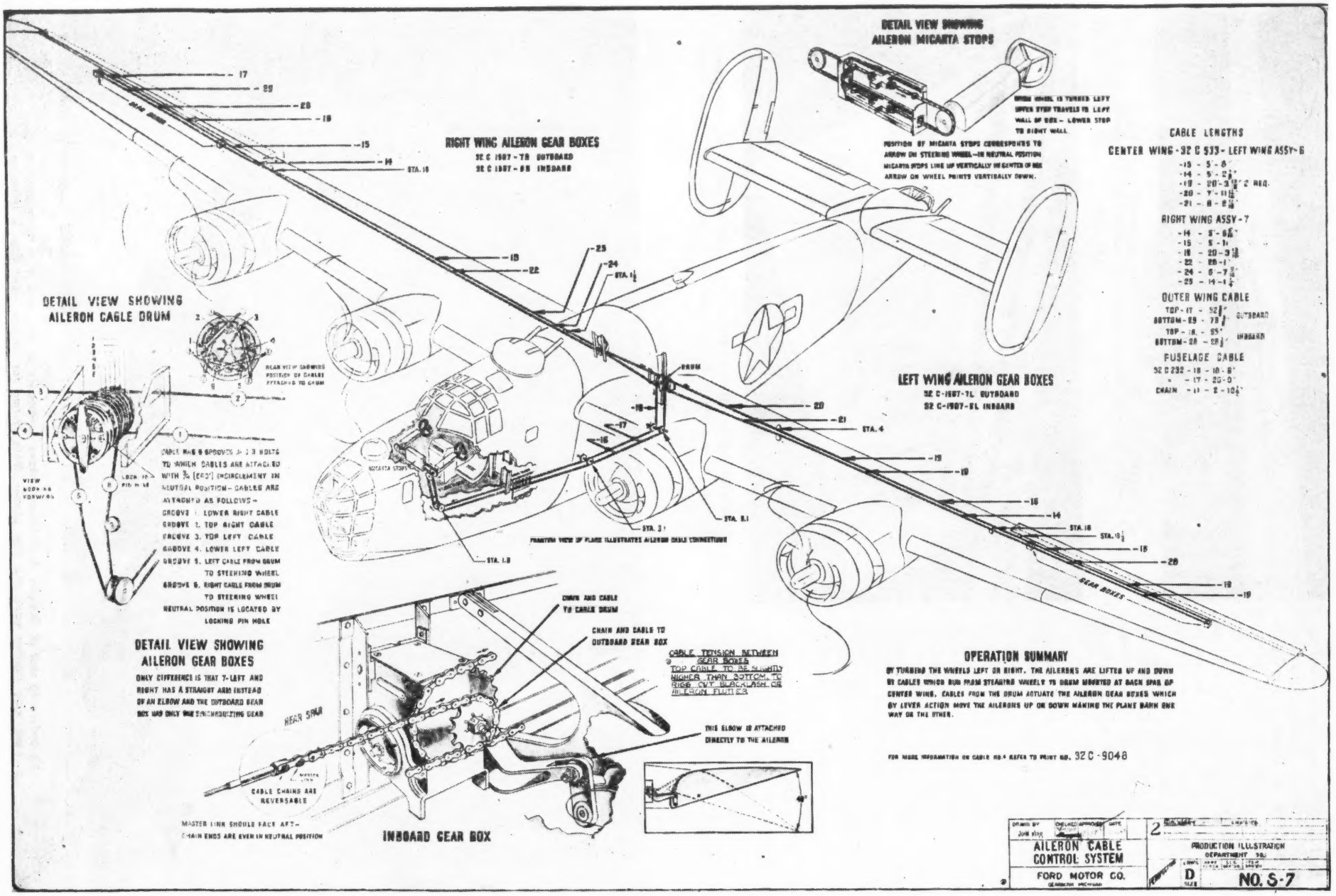

DETAIL VIEW SHOWING AILERON MICARTA STOPS
RIGHT WING AILERON GEAR BOXES
32 C 1987 - 7R OUTBOARD
32 C 1987 - 8R INBOARD
CABLE LENGTHS
CENTER WING - 32 C 533 - LEFT WING ASSY - 6
RIGHT WING ASSY - 7
OUTER WING CABLE
FUSELAGE CABLE
DETAIL VIEW SHOWING AILERON CABLE DRUM
LEFT WING AILERON GEAR BOXES
32 C-1987-7L OUTBOARD
32 C-1987-8L INBOARD
DETAIL VIEW SHOWING AILERON GEAR BOXES
ONLY DIFFERENCE IS THAT 7- LEFT AND RIGHT HAS A STRAIGHT ARM INSTEAD OF AN ELBOW AND THE OUTBOARD GEAR BOX HAS ONLY ONE SYNCHRONIZING GEAR
CHAIN AND CABLE TO CABLE DRUM
CHAIN AND CABLE TO OUTBOARD GEAR BOX
CABLE TENSION BETWEEN GEAR BOXES
TOP CABLE TO BE SLIGHTLY HIGHER THAN BOTTOM, TO RIGG OUT BLACKLASH OF AILERON FLUTTER
THIS ELBOW IS ATTACHED DIRECTLY TO THE AILERON
CABLE CHAINS ARE REVERSABLE
MASTER LINK SHOULD FACE AFT - CHAIN ENDS ARE EVEN IN NEUTRAL POSITION
INBOARD GEAR BOX
OPERATION SUMMARY
BY TURNING THE WHEELS LEFT OR RIGHT, THE AILERONS ARE LIFTED UP AND DOWN BY CABLES WHICH RUN FROM STEERING WHEELS TO DRUM MOUNTED AT BACK SPAR OF CENTER WING. CABLES FROM THE DRUM ACTUATE THE AILERON GEAR BOXES WHICH BY LEVER ACTION MOVE THE AILERONS UP OR DOWN MAKING THE PLANE BANK ONE WAY OR THE OTHER.
FOR MORE INFORMATION ON CABLE NO. 4 REFER TO PRINT NO. 32C-9048
AILERON CABLE CONTROL SYSTEM
FORD MOTOR CO.
PRODUCTION ILLUSTRATION DEPARTMENT
NO. S-7

Fig. 4. This perspective illustration of aileron cable control system on Ford-built Consolidated B-24 Liberator, showing proper cable hookup, is typical production drawing adaptable for service engineering bulletin.

PERSPECTIVE ILLUSTRATIONS EXPEDITE DEVELOPMENT AND PRODUCTION

PART II

IN ADDITION to the typical experimental, master change, and aircraft development illustrations featured in last month's issue, production drawings are vital links in the perspective illustration system used at the Willow Run bomber plant.

Production illustrations are frequently used for service engineering bulletins, and although the drawing shown in Fig. 4 (opposite page) was primarily made for the production department, it is typical of the perspective representations desirable for incorporation in service bulletins. Note the complexity of properly locating the ends of the six aileron cables which are attached to the cable drum, and how the graphic hookup details are further clarified by annotations.

Production procedure (Fig. 5) is another form of production illustration, and on the final assembly line the drawings give the position and part number of every piece. Where some units are not easily seen, an exploded view is added. A cardinal consideration

showing proper cable hookup, is typical production drawing adaptable for service engineering bulletin.

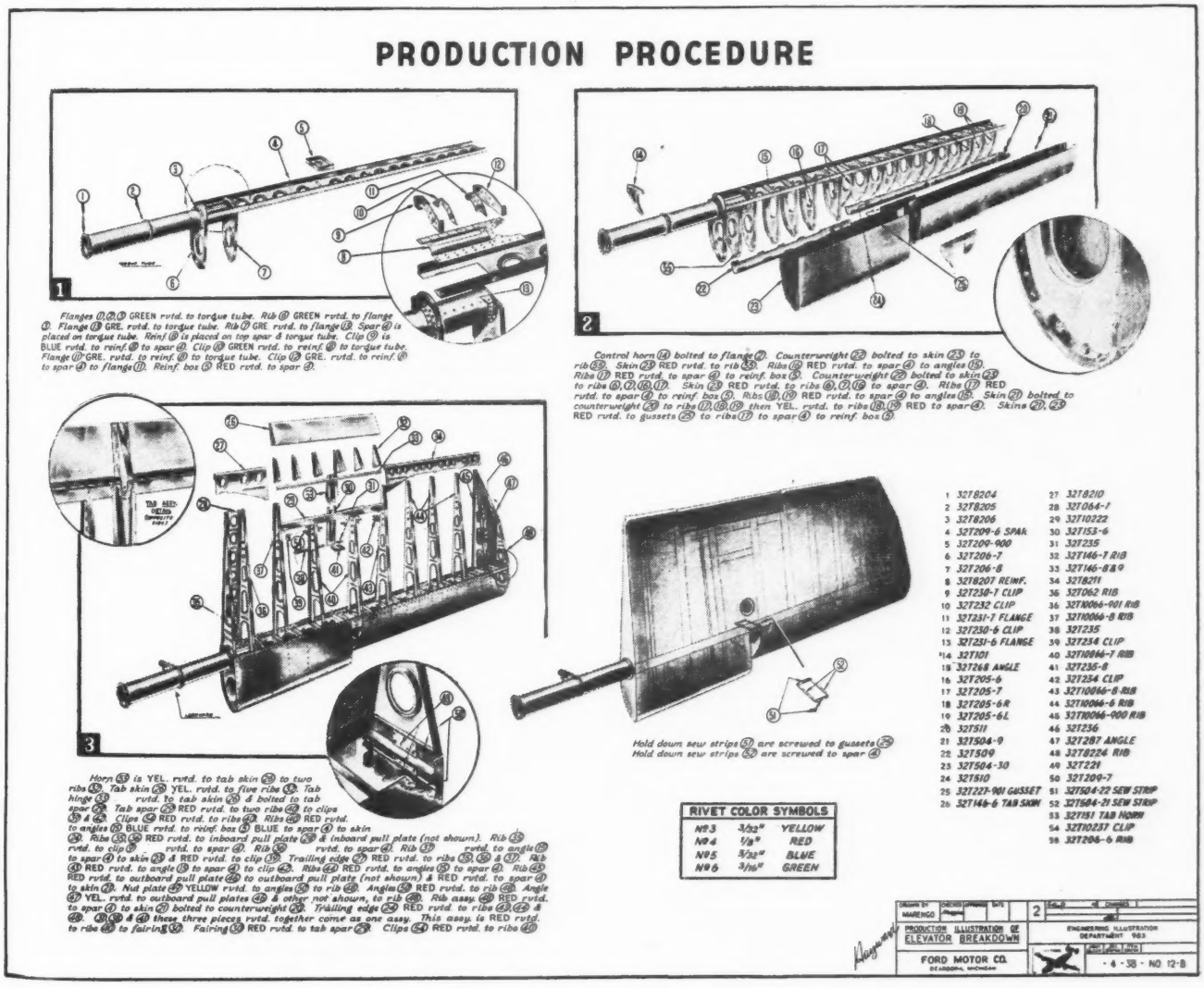

PRODUCTION PROCEDURE
1
2
3
Flanges ①,②,⑬ GREEN rvtd. to torque tube. Rib ⑭ GREEN rvtd. to flange ①. Flange ⑫ GRE. rvtd. to torque tube. Rib ⑰ GRE rvtd. to flange ⑫. Spar ④ is placed on torque tube. Reinf ⑯ is placed on top spar & torque tube. Clip ⑨ is BLUE rvtd. to reinf. ⑯ to spar ④. Clip ⑩ GREEN rvtd. to reinf. ⑯ to torque tube. Flange ⑪ GRE. rvtd. to reinf. ⑯ to torque tube. Clip ⑫ GRE. rvtd. to reinf. ⑯ to spar ④ to flange ⑪. Reinf. box ⑤ RED rvtd. to spar ④.
Control horn ⑭ bolted to flange ②. Counterweight ㉒ bolted to skin ㉓ to rib ㉕. Skin ㉓ RED rvtd. to rib ㉕. Ribs ⑲ RED rvtd. to spar ④ to angles ⑮. Ribs ⑰ RED rvtd. to spar ④ to reinf. box ⑤. Counterweight ㉒ bolted to skin ㉓ to ribs ⑧,⑫,⑯,⑰. Skin ㉓ RED rvtd. to ribs ⑥,⑦,⑧ to spar ④. Ribs ⑰ RED rvtd. to spar ④ to reinf. box ⑤. Ribs ⑱,⑲ RED rvtd. to spar ④ to angles ⑮. Skin ㉑ bolted to counterweight ㉒ to ribs ⑰,⑱,⑲ then YEL. rvtd. to ribs ⑱,⑲ RED to spar ④. Skins ㉑,㉓ RED rvtd. to gussets ㉕ to ribs ⑰ to spar ④ to reinf. box ⑤
Horn ㉝ is YEL. rvtd. to tab skin ㉘ to two ribs ㉙. Tab skin ㉘ YEL. rvtd. to five ribs ㉙. Tab hinge ㉛ rvtd. to tab skin ㉘ & bolted to tab spar ㉚. Tab spar ㉚ RED rvtd. to two ribs ㉙ to clips ㉜ & ㊷. Clips ㊷ RED rvtd. to ribs ㉙. Ribs ㉙ RED rvtd. to angles ㉟ BLUE rvtd. to reinf. box ⑤ BLUE to spar ④ to skin ㉔. Ribs ㉟,㊱ RED rvtd. to inboard pull plate ㊴ & inboard pull plate (not shown). Rib ㉟ rvtd. to clip ㉜ rvtd. to spar ④. Rib ㊱ rvtd. to spar ④ Rib ㉟ rvtd. to angle ㉟ to spar ④ to skin ㉔ & RED rvtd. to clip ㉜. Trailing edge ㉖ RED rvtd. to ribs ㉙,㊱ & ㊲. Rib ㊵ RED rvtd. to angle ㉟ to spar ④ to clip ㊷. Ribs ㊹ RED rvtd. to angles ㉟ to spar ④. Rib ㊸ RED rvtd. to outboard pull plate ㊹ to outboard pull plate (not shown) & RED rvtd. to spar ④ to skin ㉔. Nut plate ㊺ YELLOW rvtd. to angles ㊱ to rib ㊸. Angles ㊱ RED rvtd. to rib ㊸. Angle ㊺ YEL. rvtd. to outboard pull plates ㊹ & other not shown, to rib ㊸. Rib assy. ㊸ RED rvtd. to spar ④ to skin ㉔ bolted to counterweight ㉒. Trailing edge ㉖ RED rvtd. to ribs ㊷,㊸ & ㊾. ㊼,㊽ & ㊿ these three pieces rvtd. together come as one assy. This assy. is RED rvtd. to rib ㊸ to fairing ㊻. Fairing ㊻ RED rvtd. to tab spar ㉚. Clips ㊼ RED rvtd. to ribs ㊸
Hold down sew strips ㊾ are screwed to gussets ㉕
Hold down sew strips ㊾ are screwed to spar ④
1 3218204
2 3218205
3 3218206
4 321209-6 SPAR
5 321209-900
6 321206-7
7 321206-8
8 3218207 REINF.
9 321230-7 CLIP
10 321232 CLIP
11 321231-7 FLANGE
12 321230-6 CLIP
13 321231-6 FLANGE
14 321101
15 321268 ANGLE
16 321205-6
17 321205-7
18 321205-6R
19 321205-6L
20 321511
21 321304-9
22 321509
23 321504-30
24 321510
25 321227-901 GUSSET
26 321146-6 TAB SKIN
27 3218210
28 321064-7
29 32110222
30 321153-6
31 321235
32 321146-7 RIB
33 321146-8 & 9
34 3218211
35 321062 RIB
36 32110066-901 RIB
37 32110066-8 RIB
38 321235
39 321234 CLIP
40 32110066-7 RIB
41 321235-8
42 321234 CLIP
43 32110066-8 RIB
44 32110066-6 RIB
45 32110066-900 RIB
46 321236
47 321287 ANGLE
48 3218224 RIB
49 321221
50 321209-7
51 321504-22 SEW STRIP
52 321504-21 SEW STRIP
53 321151 TAB HORN
54 32110237 CLIP
55 321206-6 RIB
RIVET COLOR SYMBOLS
NO 3 3/32" YELLOW
NO 4 1/8" RED
NO 5 5/32" BLUE
NO 6 3/16" GREEN
DRAWN BY MARENGO
CHECKED
APPROVED
DATE
2
PRODUCTION ILLUSTRATION OF ELEVATOR BREAKDOWN
FORD MOTOR CO. DEARBORN, MICHIGAN
ENGINEERING ILLUSTRATION DEPARTMENT 983
PART NO.
DATE
- 4 - 38 - NO 12-8

Fig. 5. Production procedure drawing of B-24 elevator assembly depicts construction details in manner easily understood by assembly line personnel.

in connection with these final assembly drawings is that they be maintained up-to-date, and if changes are made overnight a new print is at the proper station on the assembly line before the next shift goes to work. Usually, this procedure is carefully timed with the block changes. The prints, thus serving as a form of daily newspaper for production line workers, are marked to clearly show the changes.

The furnishings illustration shown in Fig. 6 is another form of production drawing used to indicate the location of various installations. Parts to be added are pencil-shaded over the line drawing to make them stand out.

Tool design illustrations, frequently more complicated and finished than those employed for aircraft details, are used to obtain approval of tool committees and for getting cost estimates from tool builders.

The advantages of this comprehensive system of perspective illustrations indicates a method for obtaining economies in the creation of postwar aircraft designs and getting new planes into production. Engine manufacturers also see value in this illustration technique as a means of facilitating design, of aiding in the construction of patterns and dies, and of acquainting the production staff with the fabrication of new parts—because this type of drawing, as compared with the standard engineering projection, is so much more easily understood by the average worker.

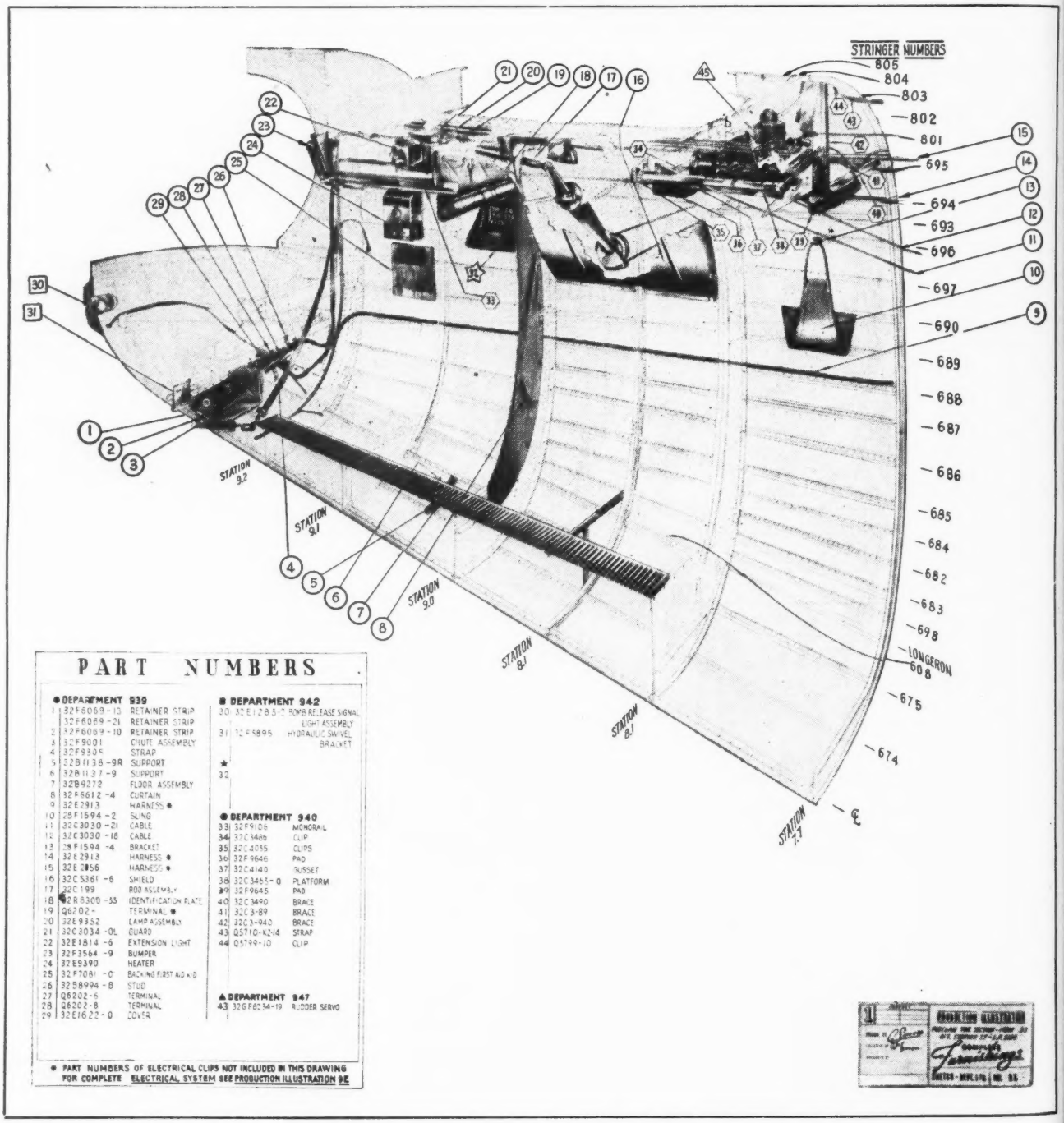
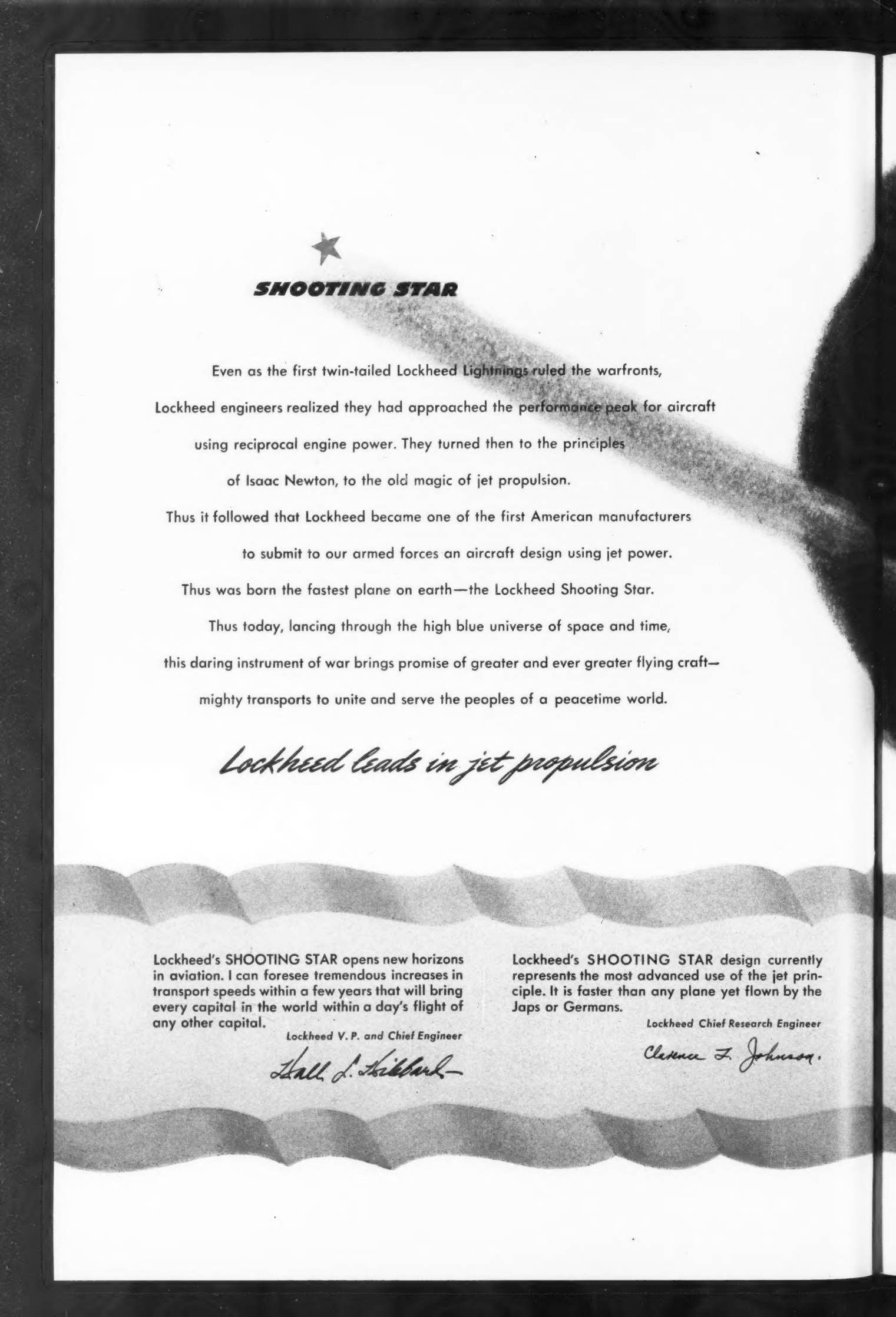


Fig. 6. Furnishings illustration seen here—another form of production drawing—indicates location of units, shaded for emphasis.

Jet PROPULSION
The sensational jet-propelled Lockheed SHOOTING STAR
is the fastest, highest-flying super-fighter in all the world.
Again proof that Lockheed is years ahead in the science of flight.
LOCKHEED LEADS AGAIN



SHOOTING STAR

Even as the first twin-tailed Lockheed Lightnings ruled the warfronts,
Lockheed engineers realized they had approached the performance peak for aircraft
using reciprocal engine power. They turned then to the principles
of Isaac Newton, to the old magic of jet propulsion.
Thus it followed that Lockheed became one of the first American manufacturers
to submit to our armed forces an aircraft design using jet power.
Thus was born the fastest plane on earth—the Lockheed Shooting Star.
Thus today, lancing through the high blue universe of space and time,
this daring instrument of war brings promise of greater and ever greater flying craft—
mighty transports to unite and serve the peoples of a peacetime world.

Lockheed leads in jet propulsion

Lockheed's SHOOTING STAR opens new horizons in aviation. I can foresee tremendous increases in transport speeds within a few years that will bring every capital in the world within a day's flight of any other capital.

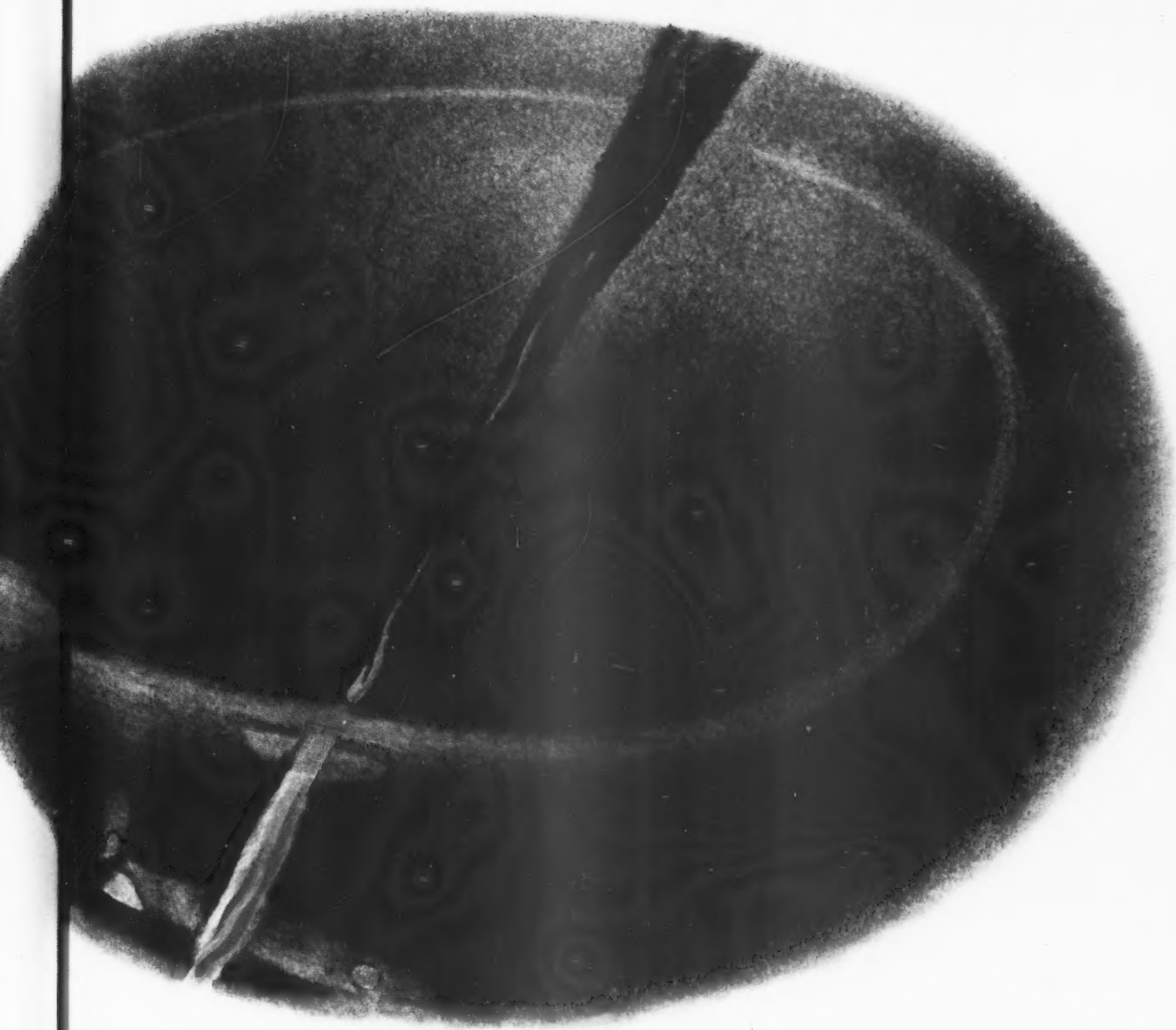
Lockheed V. P. and Chief Engineer

Hall L. Hibbard

Lockheed's SHOOTING STAR design currently represents the most advanced use of the jet principle. It is faster than any plane yet flown by the Japs or Germans.

Lockheed Chief Research Engineer

Clarence L. Johnson



Lockheed's SHOOTING STAR is a pilot's airplane—clean, fast, maneuverable. It has a terrific fire power. There is no comparable airplane in the air today.

Lockheed Chief Engineering Test Pilot

Tony LeVier

Lockheed's SHOOTING STAR is comparatively simple to build, service, repair and fly. Five factories are concentrating on mass production to meet the demands of the United States Army.

Lockheed P-80 Production Supervisor

Harry Christen

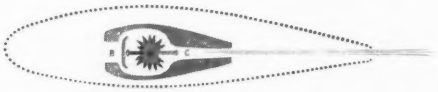
LITTLE-KNOWN FACTS ABOUT

Jet PROPULSION

(1) Most common misconception concerning jet propulsion is the idea that forward thrust of the airplane is obtained by the rush of hot gases from a narrow opening pushing against a cushion of air behind the plane.

(2) The jet principle derives from elementary physics: *to every action there is an opposed reaction which is equal in force and opposite in direction.* For instance, (see the above diagram), explosion (A) creates equal forces (B) and (C).

(3) In jet propulsion force (B) is the impelling force of the airplane. It is captured by the front end of the jet engine. Force (C), although equal, is dissipated as compressed gases escape through the narrow jet opening at rear of the plane.



(4) The entire motion of the jet-propelled airplane is caused by internal pressures. Air resistance opposing this movement is minimized by advanced design, such as that incorporated in the Lockheed Shooting Star.

LOCKHEED

LOOK TO *Lockheed* FOR LEADERSHIP

Years ahead in the science of flight

LOCKHEED AIRCRAFT CORPORATION · BURBANK, CALIFORNIA

CONVAIR PRODUCES RY-3 MILITARY TRANSPORT

A version of PB4Y-2 Privateer, new RY-3 is designed to do triple duty as passenger-ambulance-cargo plane for U. S. Navy and RAF. It features single rudder and modified Davis wing, also incorporates special hot-air heating system for warming cabin and preventing ice formation.

DESIGNATED THE RY-3, a new four-engine cargo-transport airplane is being manufactured by Consolidated Vultee at the company's San Diego plant for the U. S. Navy and RAF Transport Command.

Powered by four 1,350-hp. Pratt & Whitney Twin Wasp engines, the RY-3, a development of Convair's Privateer PB4Y-2, has a gross weight of about 60,000 lb., and carries a useful load of approximately 30,000 lb. This can include 28 passengers, or 26 litters as an ambulance plane, plus a crew of four. Range is more than 3,000 mi. Span is 110 ft., height slightly over 29 ft., and length is 75 ft. 5 in.

Fuselage interior has a compartment in the nose for luggage and cargo. Aft of this and in the lower part of the fuselage is the nose landing gear well. Directly over the nose gear compartment is the flight deck. Behind the flight deck is the main passenger and cargo section. Stowage room for life raft equipment and also compact toilet facilities are situated in this latter section.

The RY-3 wing is an adaptation of the Davis-design Liberator wing. A two-spar structure, it is made up of a center section with wing flaps, two outer panels fitted with ailerons, and removable wing tips. Self-sealing fuel cells are between the center section spars, and an oil tank is on the mount inside each engine nacelle.

One of the plane's outstanding features is the single-rudder tail assembly, which creates less drag than double-rudder assemblies such as used on former Convair designs.

A new hot air system is employed for cabin heating and to prevent ice formation. It uses engine exhaust gases to heat air, which is then distributed through ducts to all parts of the airplane.

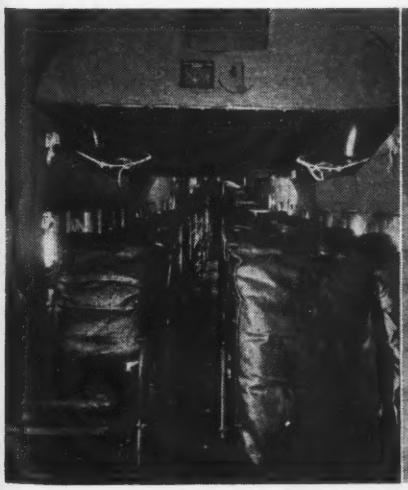
Design work on the RY-3 started in Oct. 1943 and a prototype first flew about six months later.

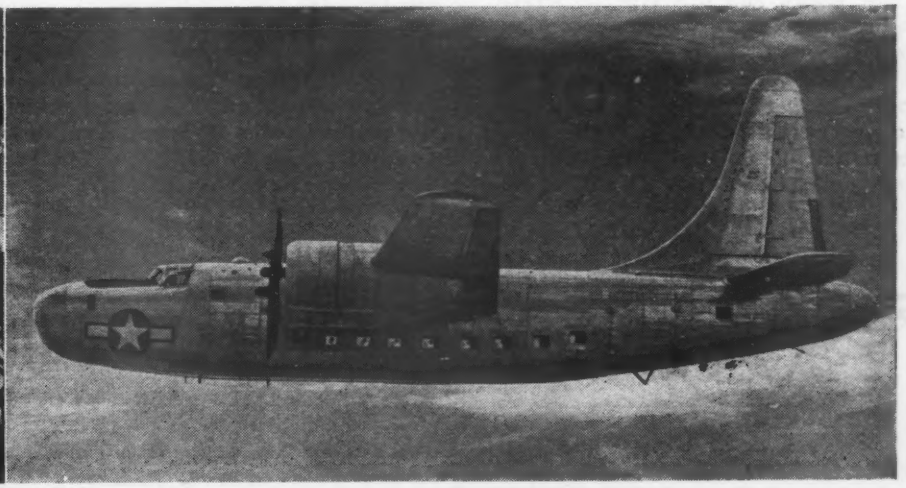
Specifications and Data

Span	110 ft.
Length	75 ft. 5 in.
Height	about 29 ft.
Gross wt.	about 60,000 lb.
Useful load	about 30,000 lb.
Top speed	over 250 mph.
Range	over 3,000 mi.
Passengers	28
Litters	26
Crew	4
Power plants	Four 1-350-hp. P&W Twin Wasps
Propellers	Hamilton Standard Hydromatics

Here is main passenger compartment, situated behind flight deck. Seats can be removed and 26 litters fitted, or entire space may be used for cargo.

Consolidated Vultee RY-3 is Navy's latest long range transport plane. Carrying a useful load of about 30,000 lb., which may consist of 28 passengers or 26 litters for wounded cases, plus a crew of four, it has a range of over 3,000 mi. and a top speed of over 250 mph. It is now in production for NATS and RAF Transport Command. (Otto Menge photo)





PICK-UP FLYING USES 87% ENGINE H P.

THIS month All American Aviation, Inc. completes its 6th year of Air Pick-Up Service — the country's toughest air mail operation. A feeder for main airlines, All American picks up and delivers air mail and air express, without stopping, at points lacking regular airport facilities . . . now serves 118 cities and towns in six states, flies its ten-plane fleet close to a million and a quarter actual revenue miles annually.

Because of short distances between pick-up points, All American's planes fly at low levels; and this type of service requires that engines operate continuously at 87% of their hp. In addition, full take-off power is applied at the moment of every pick-up — an average of once every eight minutes in flight. These factors add up to greater-than-ordinary strain on engines. Only an oil of outstanding quality can stand up under the high temperatures and pressures caused by these severe conditions.

In selecting *Texaco Aircraft Engine Oil* exclusively for its planes, All American puts itself in good company. The wide preference for Texaco by leading airlines is evidenced by the fact that —

More revenue airline miles in the U. S. are flown with Texaco than with any other brand.

A Texaco representative will gladly help you select the most suitable lubricants and fuels for your requirements . . . and furnish suggestions for the improvement of operating and maintenance practices.

Texaco Aviation Products are available through more than 2300 Texaco distributing plants in the 48 States. The Texas Company, *Aviation Division,* 135 East 42nd Street, New York 17, N. Y.

RECONVERSION RUSTPROOFING

5 Points to Remember

1. Upon termination of war contracts, Government-owned production equipment must be rustproofed promptly, in accordance with *official instructions.*
2. Ordnance Specification P.S. 300-4 contains *official instructions* for the complete processing of such equipment.
3. These instructions require that only rustproofing materials meeting Government specifications be used.
4. *Texaco rustproofing products meet Ordnance specifications for application on Government-owned equipment.*
5. For full information, see your Texaco representative or write to us.

TEXACO Lubricants and Fuels

FOR THE AVIATION INDUSTRY

TUNE IN THE TEXACO STAR THEATRE WITH JAMES MELTON EVERY SUNDAY NIGHT — CBS

Modern Engine Overhaul Demands Basic Business Methods

PART IV OF A SERIES

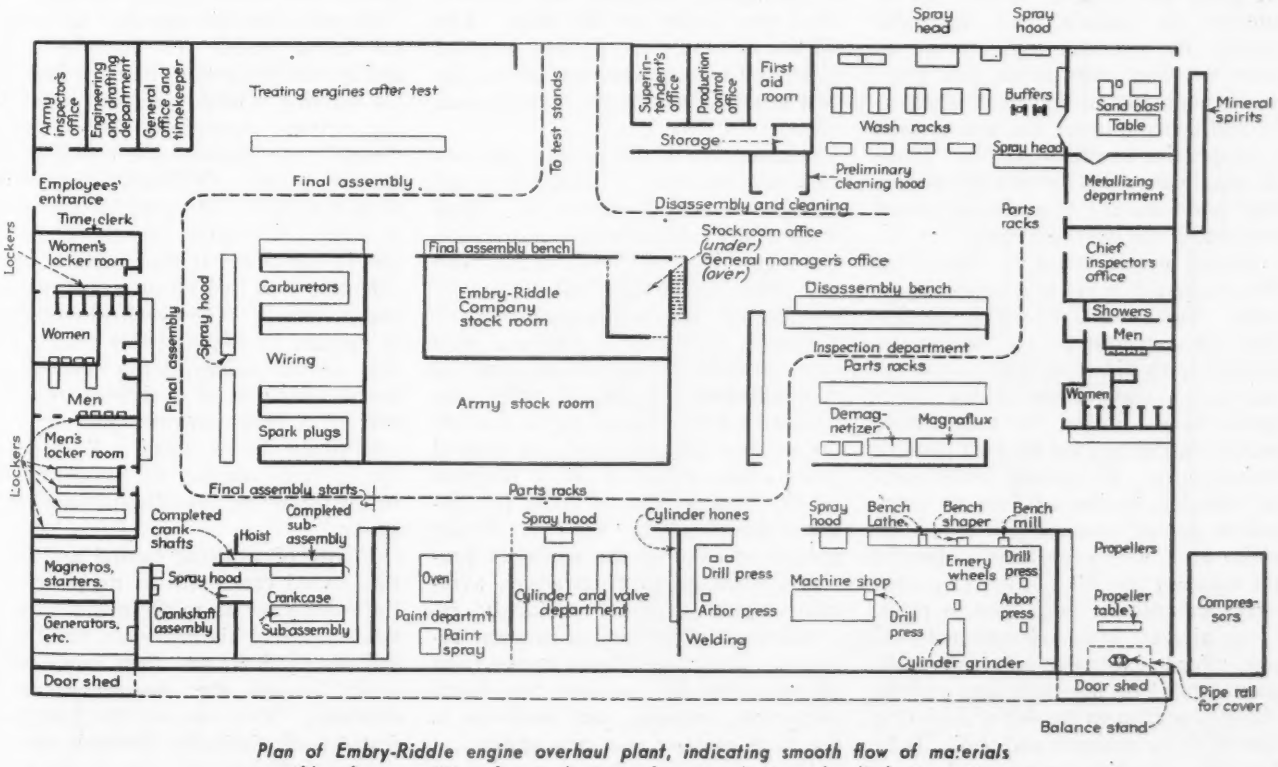
By E. L. LINDSLEY

Gone is the rule-of-thumb overhauler who valued work "by guess" after doing it "by golly" . . . Today's successful engine-service operator must acquire precise working equipment, then must balance its expense within a tight work-price range. He must solve pertinent problems of routine, production flow, inventory, and merchandising—and then bind them all together with a foolproof cost accounting system. Above all, he must decide, wisely, whether to represent one or several engine makers—or work "on his own."

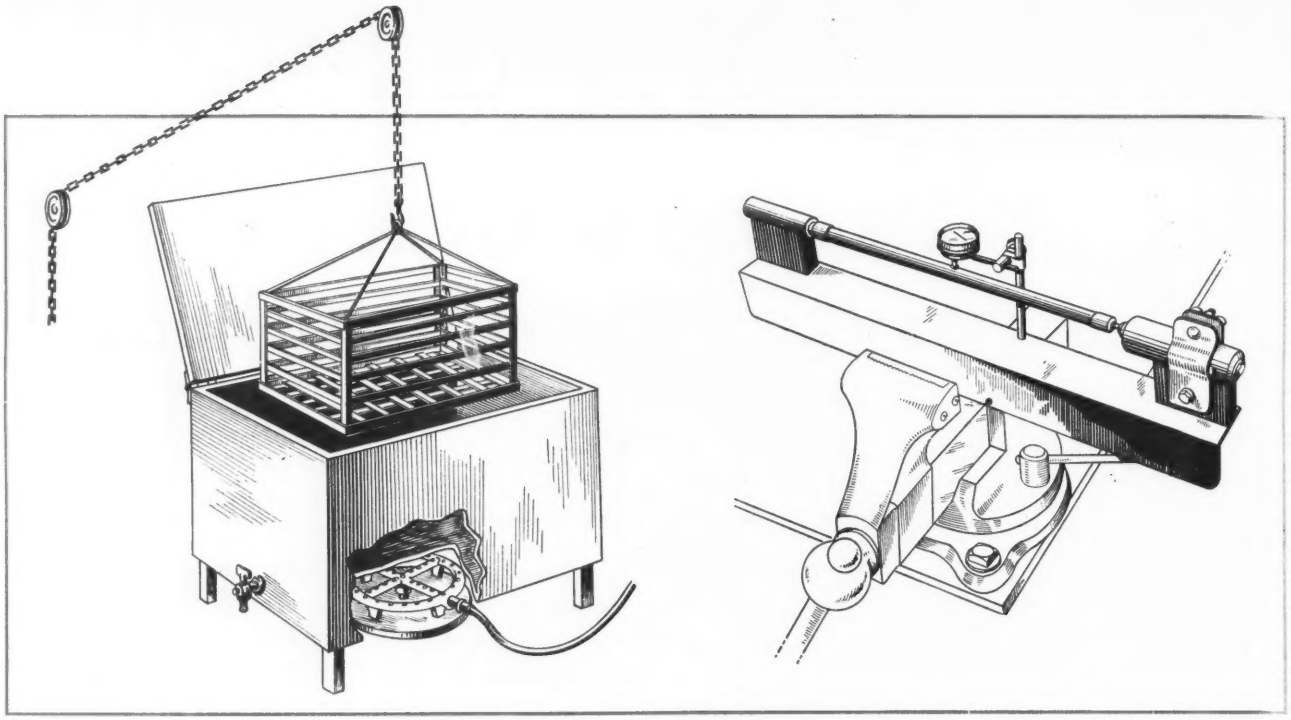
AIRCRAFT AND THEIR ENGINES do not wear out in the same manner that a truck wears out. Progressive deterioration, frequent in ground transport, is not permitted. Economic factors concerned with payload, speed, range, operating charges, competition, and customer appeal, impel airlines eventually to write a plane and its engines off the books. But for proof that such planes are not actually worn out one need only observe the records established by our airlines' "retired" Boeing 247's or venerable Ford Trimotors in South and Central America.

Engine overhaul may be termed an endeavor apart. Its language is the language of the machine shop, its essence is of the production line, and its objective is, with certain exceptions, financial.

Briefly, it is the overhaul operator's task to manage his station, department, or depot, in such a manner that two basic requirements are satisfied. First he must overhaul the engine within a price range over which he has little control. This price is a monetary representation of the overhauled en-



Plan of Embry-Riddle engine overhaul plant, indicating smooth flow of materials possible when quantities of a single type of power plant are handled at one time.



Heated by removable gas ring and with drain for changing liquid, single tank combines both soaking and washing operations.

Built from junk by UAL mechanics, this valve push rod checker tests straightness within .01 in. by means of movable dial indicator.

gine's utility. Too high a price disallows the owner's proper return on his investment. This engine owner and operator cannot charge more for the engine's commercial usage than will be gained by the passengers and cargo.

Still adhering to economics, the commercial airplane operator is always anxious to sell the marginal consumer who would ship or travel by air if the price were slightly lower. In an attempt to satisfy this marginal market, the operator will attempt to lower overhaul costs in his own shop, or, if employing an outside contractor, he will demand lower charges or seek a competitive overhaul station. Thus, the maximum price for an engine overhaul is established by economic forces external to the overhaul shop.

Second major factor of concern to the overhauler is his own cost of operation. Any amount of precision equipment is available to the operator—according to his capability as a business man to make it pay its way. Here again he is limited by the uncompromising demand for the best possible maintenance. He cannot lower costs by omitting quality as does an automobile garage operating in a low income area where customers demand the cheapest possible service. He must never subordinate perfection to price. If an aircraft overhaul operator cannot afford expensive equipment, he must depend on ingenuity and pay the wages of craftsmen capable of achieving fine work by patience and skill. If he buys the expensive equipment, he must swell his business volume to reduce unit cost and be prepared to face the labor problems inherent in the lower wage personnel normally employed to operate single-task mass-production machinery.

Profits are squeezed—between the relatively fixed vise jaw of maximum cost as limited by economic utility, on one side, and the partially movable jaw of machinery, overhead, and material costs, plus wages on the other. The old law of supply and demand, coupled with quality requirements, forms the jack-screw tightening the metaphorical vise.

Innumerable would-be entrepreneurs view the postwar aviation sales and service field with a covetous eye. Most of them are relatively new to aviation and regard it as ripe fruit for him who will pluck it, but they will do well to consider the economic factors involved.

Engine overhaul, in common with most mechanical operations, may be accomplished, if necessary, under conditions that leave much to be desired. As aviation grew through the painful years, engine overhaul slowly outgrew its old "best we can do under the circumstances" status until it finally gained prestige in the world of precision work, so that nowadays, aviation engine overhaul strikingly resembles actual production in many respects. This resemblance comes from the necessity for complete tear-down, inspection, renewal, and build-up in the same manner as a new engine.

Let us examine some of the factors as they affect the overhaul operator:

First, the overhaul station represents a heavy capital investment—much heavier than required for simple line maintenance. Following the expense of the basic precision machine tools is the high cost of special tools, pullers, and apparatus (often usable on only one model) which are frequently rendered useless if the manufacturer produces even minor design changes.

Second, after the operator has made his initial outlay for machine tools and special equipment, he must look to his working capital if he plans to touch the private operations field at all. Consider, for instance, the 4- or 5-place private plane. Ordinarily, overhaul of such a plane and its engine proceeds at a fairly slow pace. By the time the job is completed it represents a considerable sum tied up in wages, parts, and materials. The overhaul operator is entitled to a reasonable return on this buried money, while the plane owner feels that he is entitled to some sort of a time payment plan on the admittedly large costs. Eventually the operator obtains his payment, but in the meantime payrolls and overhead go on.

Plenty of working capital and well established credit are as necessary to the overhauler as to the manufacturer who must buy his materials, build and sell his product, and then await payment through the customary credit channels. Thus, we see the first two features of similarity between manufacture and overhaul—one is the need

for a large initial outlay, the other is the heavy working capital requirement.

General operations of the manufacturer and the overhauler also have much in common. Consider the overhauler's need for a carefully planned inventory of his parts and materials, the inspection and storage of incoming materials, the demand for a parts' stock large enough to prevent delay in overhaul but small enough to eliminate financial deadweight.

Continuing this comparison, one of the first operations of large-scale aviation maintenance is job breakdown, borrowed from the mass-production people, or developed because it is the most effective way to handle the maintenance of a complicated mechanism. It is interesting to watch an overhaul shop break an engine down into sub-assemblies and specialized jobs—to see this result in specialization of the employees, or as the personnel boys call it, *job classification,* and then to consider how little difference there actually is between this and manufacture.

After the overhaul is underway, we run into another manufacturer's problem—routing and production flow. To save money we avoid working on two heavy assemblies at such distant points that trucking is required to bring them together for assembly. We must give thought to shop layout, labor dispersal, and proper allocation of man-hours, so all parts are ready for assembly at about the same time, to avoid wasteful and costly storage preparations, hauling, indexing, and storekeeping. When we borrow the manufacturer's production flow and shop efficiency plans we're likely to borrow some of his labor problems.

Couple these difficulties with the ever-present problem of sales, and the problem, at least in northern regions, of seasonal variation in overhaul demand, and we find that the overhauler of aircraft and engines has a business no less complicated than that of the original manufacturer.

Let us examine some of the more obvious factors contributing to this complexity. To begin with, the manufacturer has a much clearer picture of his program from start to finish. He designs an engine for a carefully estimated market; his designers adapt their designs to the machinery and production equipment available; production planning gives purchasing a fairly accurate bill of materials to buy and also offers an analysis of job specifications to personnel procurement. In short, the manufacturer knows where he wants to go and plans ahead with a reasonable surety that discounts nothing short of revolution.

Not so with the overhauler. He must work with the products of all manufacturers regardless of the adaptability of a product's engineering to his own shop equipment. The only exception is the factory overhaul shop or an agency specializing in one make of engine. The unpredictable overhaul market is not conducive to efficient parts and material purchasing; whoever handles production planning must allow for unexpected jobs, rush orders, and sudden surges or lulls in business.

In the case of a small shop, for example, an engine that requires an unexpected amount of work might badly upset the promised completion dates of several jobs. In many respects the highly efficient production line is too inflexible for widely varying makes and models of engines or many powers by the same manufacturer.

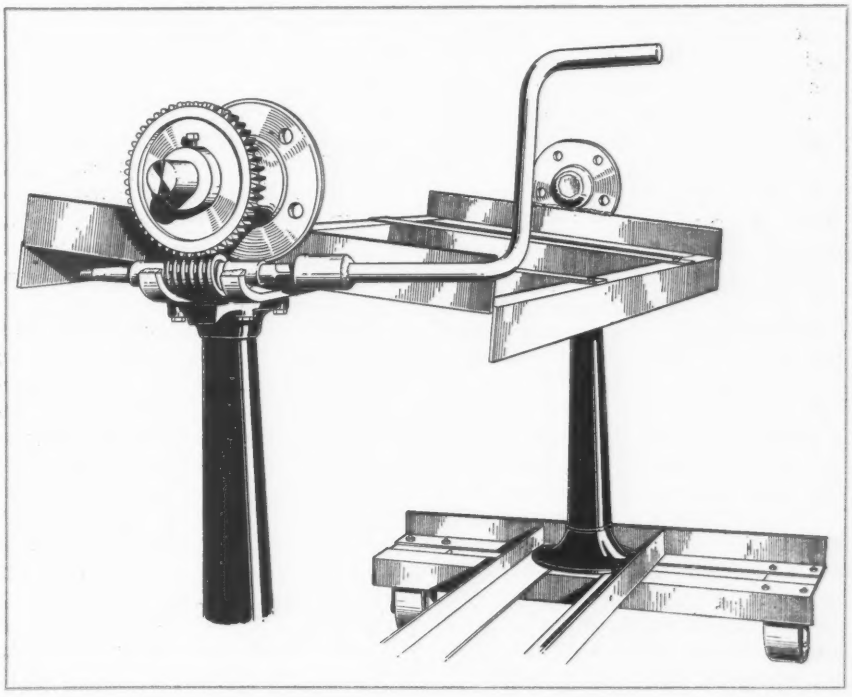
Accurate allotment of costs and charges demands that the overhauler provide some system other than the "units produced vs. total operating cost" method available to mass production. Personnel time must be kept for each job. Parts withdrawn from stock must be charged to the proper customer's account, and the more obscure items of overhead must be prorated to each completed job.

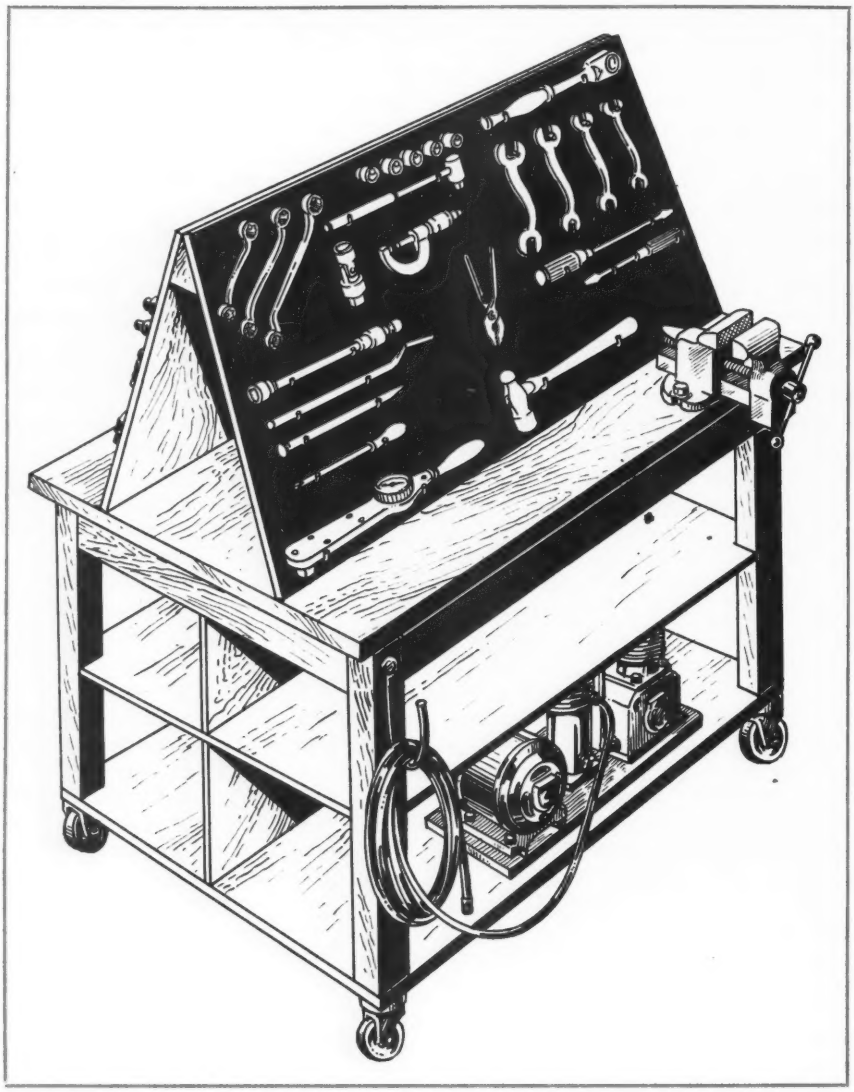
The bookkeeping problems facing the overhaul station are capable of solution because there are accounting systems and business management methods capable of solving nearly any industrial problem. The real crux of the situation seems to be hidden in the essential nature of aviation itself. An overhaul station is far too complicated to be operated according to the blacksmith-shop economic system so frequently seen in prewar days. On the other hand, in prewar times there simply was not enough business in any given area, with a few exceptions, to keep busy a well-planned overhaul shop large enough to support the kind of executive and organizational talent needed for efficient administration.

For proof of this statement one need only travel about the country and check the history of those deplorable little airports which, after being converted from hayfields with some peoples' hard won savings, were then reconverted to hayfields because the farmer's hay had greater economic value than aviation or, perhaps because the farmer was a better businessman. Where there was a business potential, those overhaul shops that did succeed were the ones that started with ample financial backing and executive power behind them.

This financial and executive problem brings us to a solution discovered years ago by the automotive industry —the dealer agency combining sales and overhaul. Thus, top-notch executives at key posts in the parent manufacturing organizations are able to spread their knowledge thin over an unlimited number of local dealer agencies. Technical assistance, economic and business advice, predictions of economic trends, standardized policies and prices, and organizational advice, are all provided for a great number of small repair shops which, individually,

Revolving engine assembly stand made by P. V. Chaffee, airport manager at Clintonville, Wis., was assembled from scrap salvaged from trucks.





This push-around type of bench, with air compressor and tool rack, was devised by a mechanic who wanted his tools always within reach and in their place..

couldn't possibly afford to hire such high-caliber assistance. Apparent advantages notwithstanding, the question of a dealer agency versus a take-all-comers overhaul station is, as yet, unsolved in aviation.

Further observation of the auto industry seems to indicate the American public's belief in the colloquial phrase, "If it doesn't work, take it back to the guy that sold it to you." Considerable advertising has been directed toward patronage of dealer-service facilities, emphasizing replacement with genuine manufacturer's parts, whereas the individual garage operator, able to service any make and model, depends for the most part on a custom clientele.

To date, aviation, in many respects has copied the dealer-service phase of the automotive trade. The motor car is a private affair, sold in millions to private individuals through dealer agencies more or less tied to a given manufacturer, whereas the larger aircraft engines, like locomotives, have always been sold exclusively by the manufacturers. The cost involved required contract building on airline or government order. Overhaul was handled by airline or government shops with a small portion directed to the factory service shops, and in recent years, another portion was contracted to a few, large, privately operated overhaul stations.

Smaller light and medium engines were sold as customer-chosen units in airplanes distributed by dealers handling several makes of aircraft and engines (there was seldom anything so exclusive as to be comparable to a Ford or Chevrolet dealership). One could, for instance, purchase a Stinson Reliant with a Lycoming, P & W, or Wright engine—plane with any one of several engines and power ratings.

Furthermore, such a dealer frequently offered the products of several aircraft manufacturers. Under these conditions, a dealer developing engine overhaul and service was forced to carry many varied parts, buy special tools for different engines, and hire the most expensive class of labor (that is, men capable of handling nearly any task).

It would seem, then, that the smart overhaul operator would do well to specialize in one manufacturer's products. This is borne out by the reluctance of the economy-wise airlines to depart from the make of engine they are set up to overhaul. The Army and Navy are also much more specialized with respect to engine makes than most people realize.

Here are some reasons for this tendency to cling to one or two manufacturers: First, it is much easier to manage parts inventories and special tools—all the way from the purchase office, through incoming inspection, down to the hook-studded boards holding gaskets and small parts in the shop.

Second, machines of the type that require precision setup may be left without the need for adjustments every time a different cylinder or master rod comes down the line .This saves manhours and cuts scrap resulting from machine operator confusion. Labor-hours spent in job changeover and valuable supervisory time lost in explaining each new task are thus avoided. Job costs may be standardized, and a semblance of mass production may be established.

If specialized overhaul seems to offer so many advantages, it is certainly fair to ask why aircraft overhaul operators have not teamed up with manufacturers as specialized representatives. Several reasons seem fairly clear. Best is the limitation imposed on the market by such specialization. Where the Chevrolet dealer, for instance, might count his prospective customers in thousands, the man equipped to overhaul one make of aircraft or engine exclusively could frequently count his possible customers on his fingers.

Certain metropolitan areas were more productive of business than this extreme example, but generally speaking the prewar days seldom offered enough engines or airplanes for any overhaul station to wax fat with an exclusive agency.

In addition to the better market spread available to the take-all-comers overhaul station, some operators considered the following points as advantages: For one thing, their machinery, being less specialized and more on the basic machine tool side, was less open to sudden depreciation through engine design changes. Others preferred to hire the skilled all-round mechanic rather than specialized machine tool

operators. A few found opportunities to fill in seasonal lulls by contracting to overhaul engines shipped in from distant areas, Alaska or South America, for example.

Sometimes it appeared that the operator was simply an individualist and his fierce love of independence prevented his tying up with any manufacturer. Many old-timers in aviation definitely may be counted in that class; they would probably have been unable to withstand the industry's growing pains had their natures been otherwise.

Some individual overhaul station operators made money by exercising ingenuity and shrewdness. In one outstanding case the operator was not only a clever business man but also a mechanical wizard. His investment was a small well-constructed brick hangar-shop and a few basic machine tools purchased at auctions, bankruptcy sales, and similar sources. With this small, but paid-for, foundation, he didn't trouble to chrome-plate the front office. Instead, he went ahead with his job of building parts-cleaning tanks from old wine vats and salvaged heating coils; constructed a remarkable engine test stand on an old truck chassis, and turned out thousands of dollars worth of special engine tools on his lathe, grinder, miller, and drill press. It is notable that he often redesigned several manufacturer's special devices so successfully that the tool-design departments asked sketches from which to rework their own product.

In addition to mechanical ingenuity, this man displayed a remarkable degree of skill in personnel and business management. When work was dull the men were kept busy building special equipment, and with each new tool turned out, new markets could be solicited. Thus, dull business periods were converted into profitable time, the station's capacity being broadened for specialized jobs.

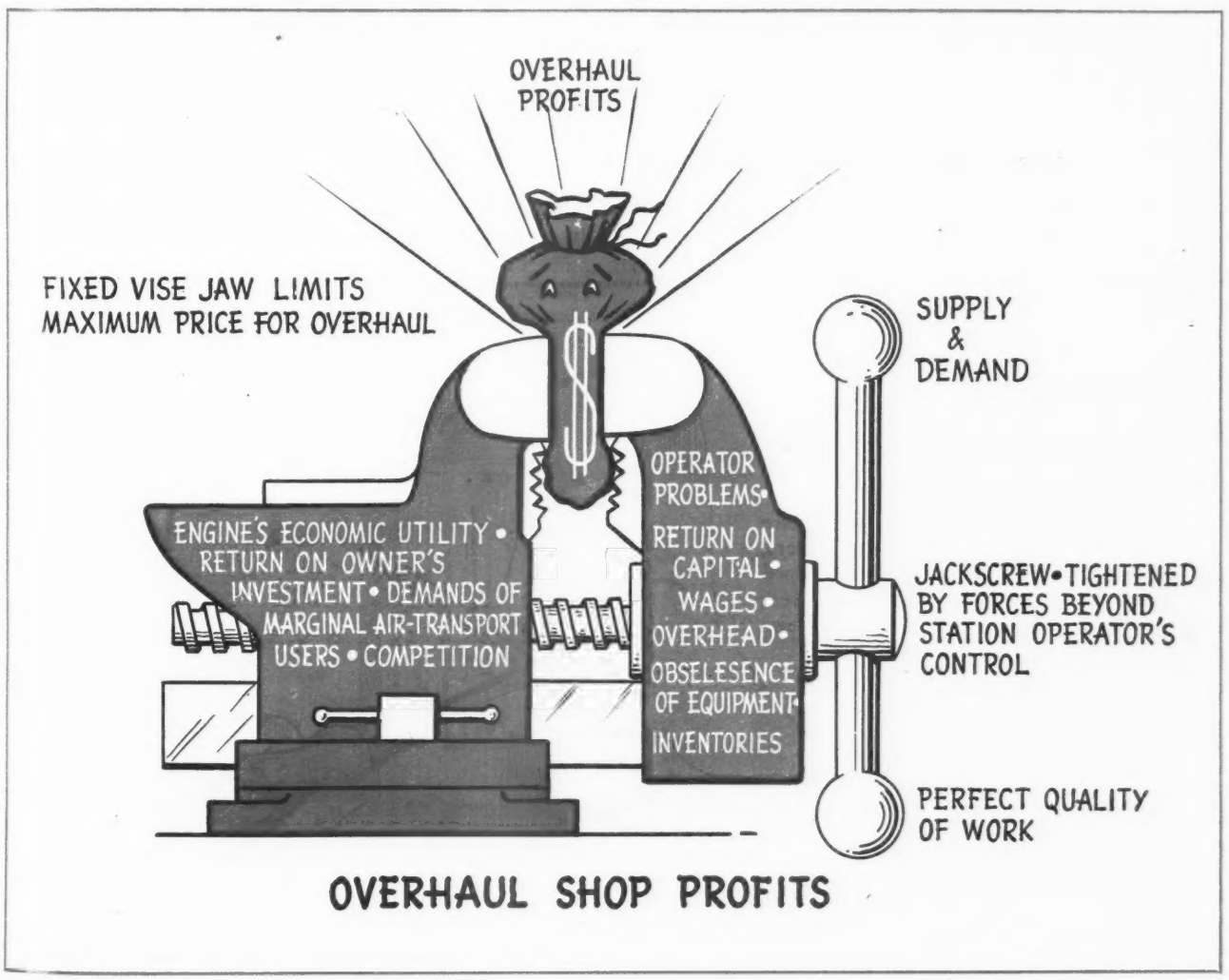
Recognizing that each engine overhaul entails many expensive hours consumed in tearing down and building up secondary items, such as baffles, ignition harnesses, primer lines, or safety wiring, this operator accepted overhaul work on condition that parts be delivered disassembled; and he returned them, after cleaning and repair, in the same condition. Thus, the man who owned the engine could avoid the expense of overhaul machinery and of hiring skilled men.

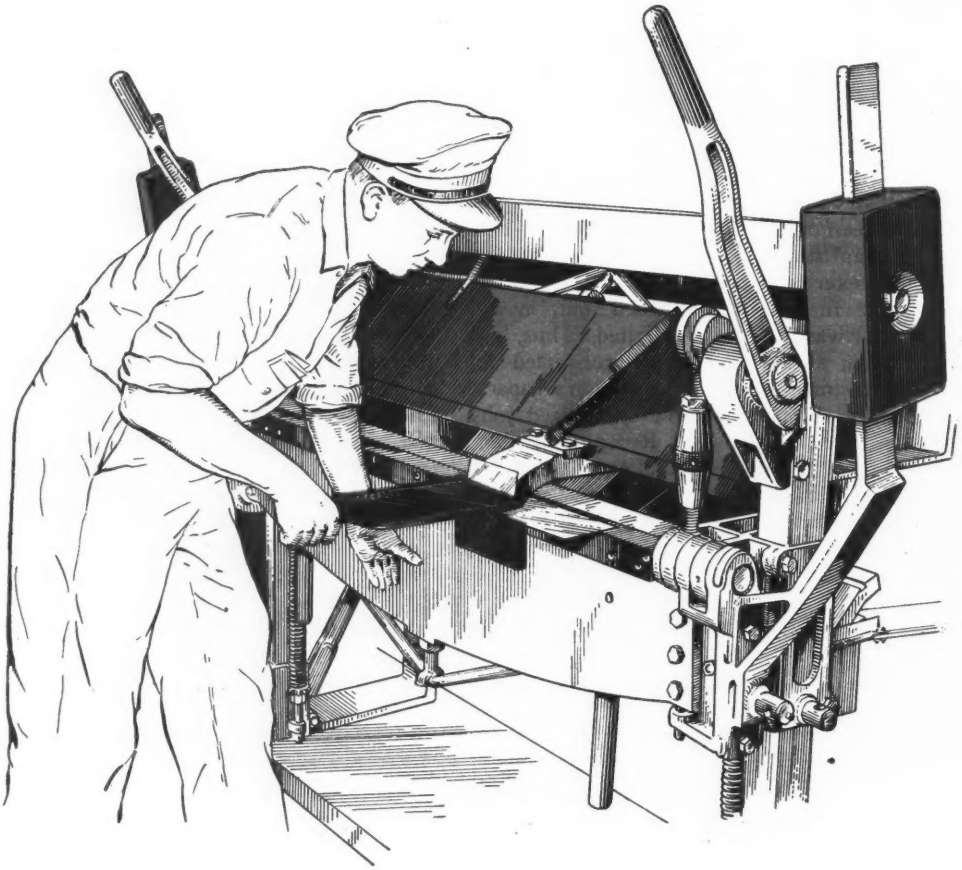
On the other hand, the overhaul man didn't waste his skilled mechanics on simple work; the precision jobs flowed steadily through the shop without interruption for time-consuming assembly on non-precision items.

This system was particularly suited to the needs of plane operators in the remote northern regions where he was situated. Freight costs were lower on individual items, such as a crate of cylinders or master rods, than they were on an entire engine. Moreover, frequent bad weather gave the customer plenty of time to assemble the engine himself without paying an overhaul station for the job.

By such methods does one overhaul station make money on an independent, non-specialized basis. Possibly this example is an exception, but it demonstrates the importance of full utilization of opportunities available to the energetic operator.

The overhaul operator's dollars are squeezed out before they can become net profits.


OVERHAUL PROFITS
FIXED VISE JAW LIMITS MAXIMUM PRICE FOR OVERHAUL
SUPPLY & DEMAND
ENGINE'S ECONOMIC UTILITY • RETURN ON OWNER'S INVESTMENT • DEMANDS OF MARGINAL AIR-TRANSPORT USERS • COMPETITION
OPERATOR PROBLEMS• RETURN ON CAPITAL • WAGES • OVERHEAD • OBSELESENCE OF EQUIPMENT• INVENTORIES
JACKSCREW•TIGHTENED BY FORCES BEYOND STATION OPERATOR'S CONTROL
PERFECT QUALITY OF WORK
OVERHAUL SHOP PROFITS

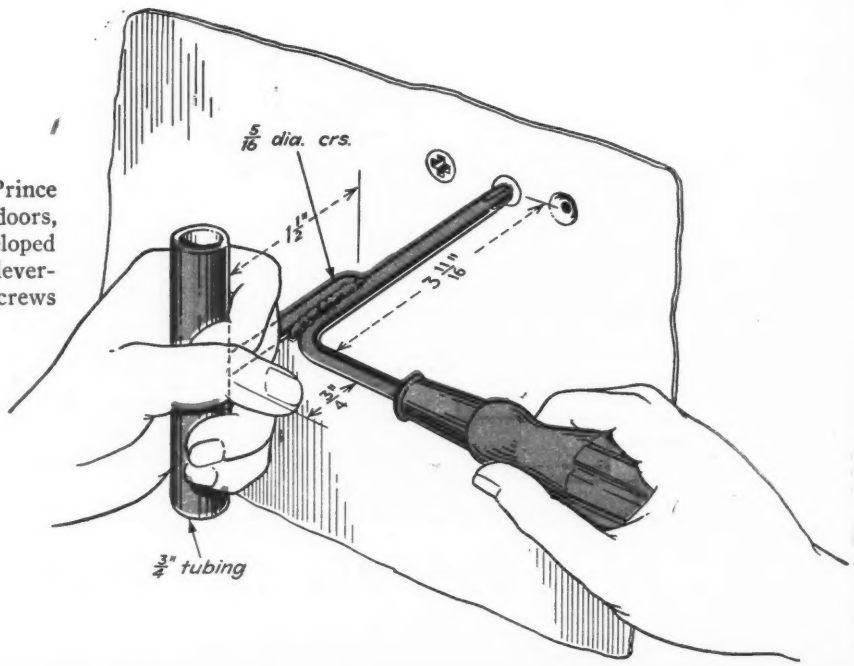


Brake Attachment Recesses Bends

• Auxiliary brake leaf, devised by George Hamill and Bert Pannier of AEA, enables making of recessed bends as simply and easily as long bends were formerly shaped.

This Tool Prevents Tank Door Leaks

• For tightening Reed & Prince screws on wing tank access doors, Douglas Santa Monica shop developed this tool, which gives sufficient leverage to enable drawing up of screws fuel-tight.

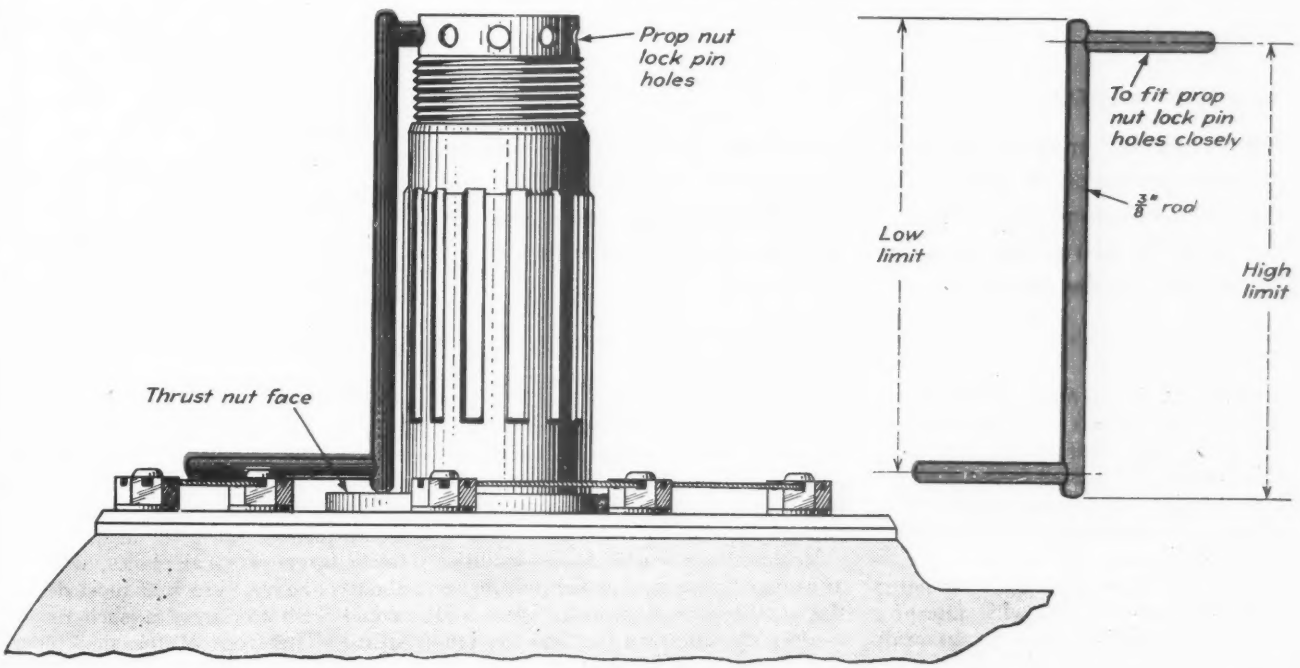


Adjustable Roller-Fitted Support Prevents Scratched Work

• Welded stand fitted with roller top on swivel mountings enables UAL's Cheyenne shops to handle sheet metal without danger of scratching or blemishes.

Handy Gage Simplifies Nose Section Adjustment

• When assembling radial engine nose sections, Naval Air Station, North Island, San Diego, uses this gage to simplify correct adjustment of rear oil transfer ring, thrust nut, and thrust bearing. Using prop nut lock pin holes to give fixed point, gage is swung across face of thrust nut. One end of gage gives high dimension and other end low dimension.



CIVIL OPERATIONS

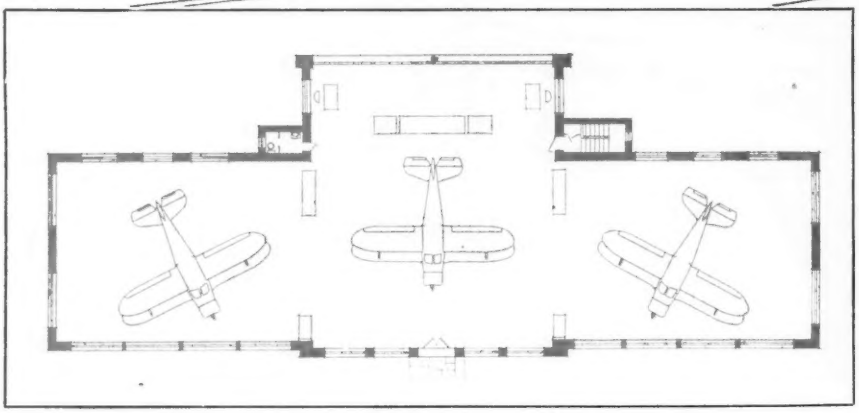


Fig. 1. Airplane showroom which can be built in sections. Completed building (as shown) would cost about $14,000. (Architect: B. E. Starr)

Fig. 2. Floor plan of building shown in Fig. 1. Sides of center section would be windows, later to be re-incorporated in wings, when built. Entire interior forms a huge display window.

Sales Are Made By Showing the Goods

By JOHN ABIUSO

The "close-up" method of arousing interest is the prime way to get the prospective plane-buyer headed for the flight line and the sales-clinching hop. Here, the modern display room will do the trick by attracting those who might otherwise remain on the "other side of the fence."

FACT IS that a plane in the air no longer attracts the attention it once did. But an aircraft suitably framed and lighted behind a plate-glass window—that is, in a convenient showroom—definitely draws the gaze of all who pass.

And there's a pointed lesson here: Commentators likely will interpret John Q. Public's disinterest in craft flying overhead as proof that he's "accepted" the airplane, but the truth is that only when he opens his checkbook will we get the kind of acceptance that means anything to the future of the business.

Required are practical sales facilities affording "close-ups" which will bring the prospects to stop, look, listen, and —after the salesman has had his innings—sign. Answer is the display room, either at the field, downtown, or both.

The design in Figs 1 and 2 is for the man who wishes to expand his show room as business warrants, while retaining at all times a building which is a complete unit and has no appearance of being unfinished.

To accomplish this end, the center portion is planned as the first section to be built, being 40 ft. wide and 48 ft. from back to front. Across the back are sliding doors with removable center post. The front consists of four windows and the entrance door, while the sides are temporarily fitted with wide windows, giving a clear view of the interior to persons approaching from either direction.

With increasing business, a wing can be added on either or on both sides of the original building, the side windows of the center portion being refitted at the end of the wings. This would provide space for at least three fairly large personal planes, which is about as heavy a stock as most dealers would wish to carry in such display space. The front of the showroom's

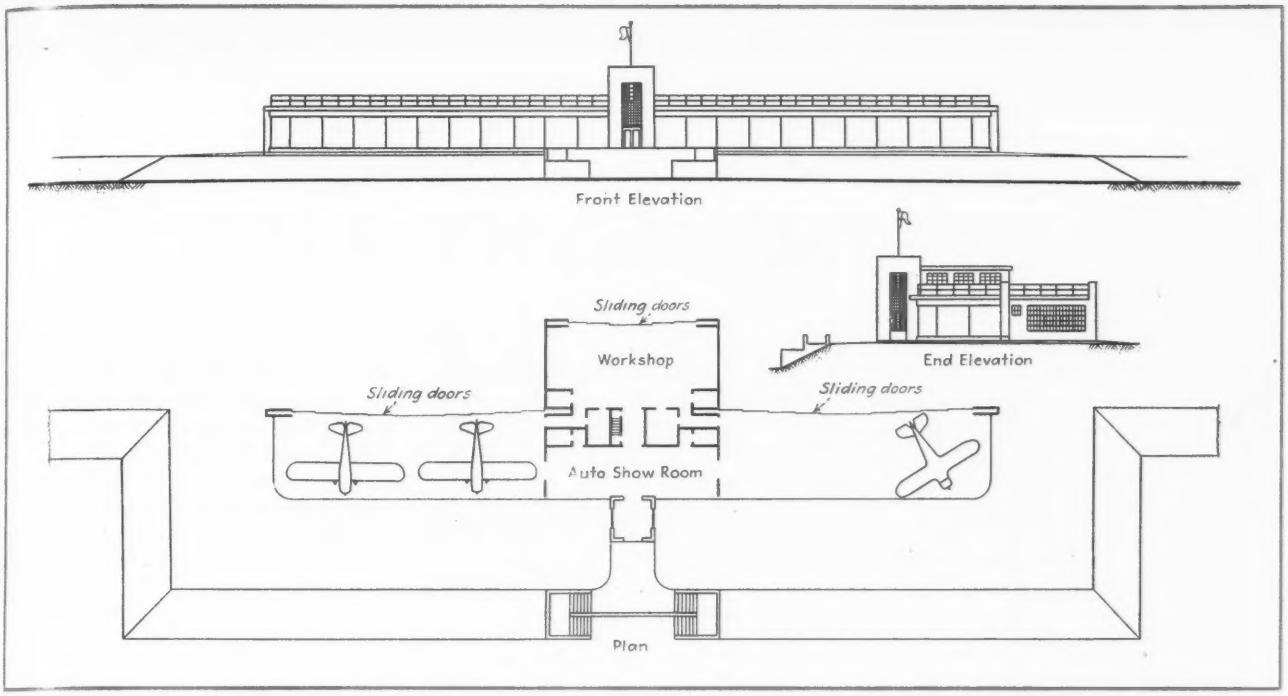


Fig. 3. This floor plan gives front and end elevations of combination plane-and-auto salesroom for large airport. Total cost would be around $28,000. Top deck, reached through showroom, would attract many prospective customers. (Architect: B. E. Starr)

center section could then be used as an office.

Estimated cost of this complete structure would be about $14,000, of which half would be for the center section. It is understood, of course, that expense estimates will vary considerably according to local conditions—cost of shipping, materials, and labor.

Where the airport is large and well situated—so that it is a part of the life of the city and not a mere stop-off place for travelers—it has been suggested that a sales company handling both airplanes and automobiles would be in a very advantageous position, with a combination showroom indicated.

This building should have a railed top deck or roof garden where the public may sit and watch the planes land and take off—a type of accommodation now offered at several large municipal airports (see Fig. 3 and 4). Access to the roof would be through the showroom, and this fact, plus the airmindedness induced in the visitors by watching the airport activities from the roof, should result in many additional sales.

Since the same office force could handle both plane and auto sales, overhead would be considerably reduced in proportion to sales volume, a condition greatly to be desired.

Construction cost is estimated to total $28,000. This, at first, appears to be a lot of money to put into a salesroom, but in reality it is a good investment when rental of a similar building—if available—is compared with it. Costs would be roughly as follows:

Excavation	$500
Taxi strips	8,200
Concrete, brick, and steel work	10,000
Glazing & painting	3,300
Heating	2,000
Electrical work	800
Plumbing & hdw	1,100
O'head & profess'l	2,590
Total	$28,490

From the above examples, the prospective dealer can develop other ideas of his own regarding a showroom project that will best suit his future business. It is especially noted that there is a great deal of merit in designs which permit future expansion without discarding or rebuilding the showroom already in use.

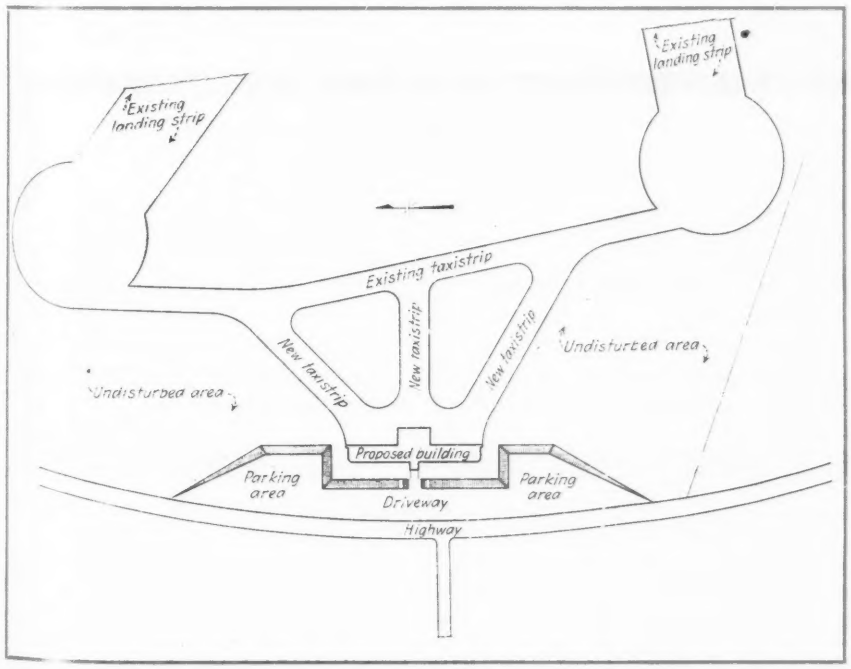
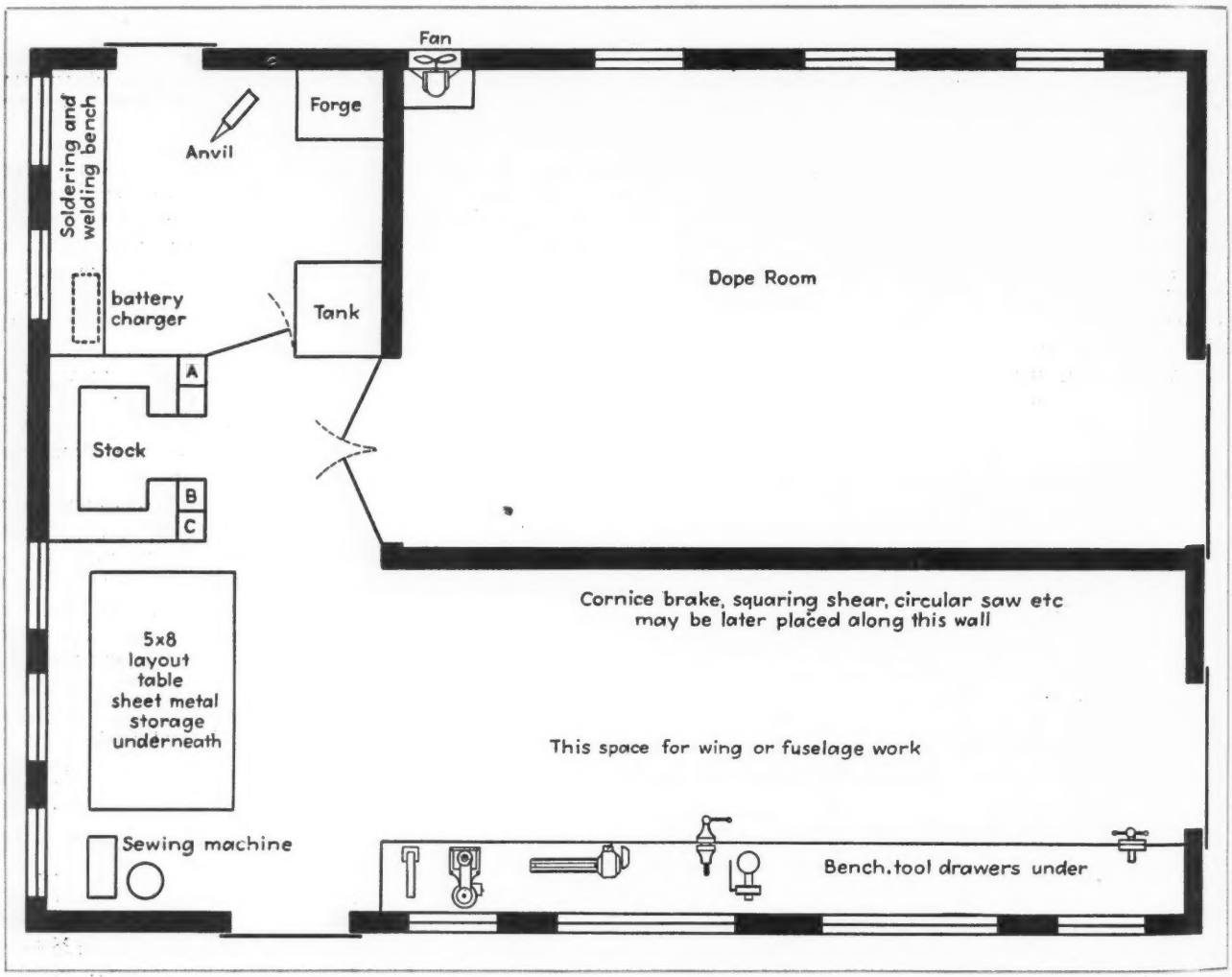


Fig. 4. Layout plan for showroom in Fig. 4. Situated on bank a few feet above highway, end windows give view of interior from considerable distance arousing curiosity of autoists and giving them time to slow down and pull into driveway.

PRACTICAL TOOLING FOR THE SERVICE BASE

RELYING UPON the collective opinion and experience of those now in the fixed-base service business, AVIATION has conducted a nationwide survey among the more successful operators and has compiled from this information an estimate of the smallest outlay in tools and machinery considered necessary for a Class I or Class II airport. To enhance this estimate, a plan is included for a shop arrangement designed to take the best advantage of a comparatively small space.

Naturally, there were varying opinions among the replies. Some of the larger operators appear to have overestimated the amount of business which a small field could expect. But, taken generally, the survey proved to be a representative consensus. It is to be noted that tools which may be made easily and quickly, such as trammels, are not listed, because a person starting a shop frequently prefers to keep his investment down by making these tools himself.



Efficient layout for 30 x 40 hangar shop. At top is separate room for welding, soldering, parts washing, forge work, and battery charging, all of which entail risk of rust on bright metal parts. Battery charger is beneath bench. Other side of wood partition is stock room, outside of which are sparkplug tester (a), valve and seat refacer (b), and emery grinder (c) located as far as possible from bench machinery (bottom of plan). On bench (left to right) are jigsaw-filing machine, drill press, and arbor press. And near corner, to isolate shavings, is wood vise, with plenty of room for the lengthy pieces and pull-out stops (not visible) for supporting long work. Compressor in dope room draws air from outside and has ventilating fan in wall above it. Right hand doors, opening into hangar, permit long work to be "switched" between shop and dope room. Door and window arrangement gives good through ventilation with any wind direction. Heating details (not shown) would be part of already installed hangar system.

As operators throughout the country gird for the job of servicing light aircraft and their engines, primary queries are: "Just what equipment do I need? And how may I lay out my shop for greatest efficiency? To get the most representative, workable answers to these questions, AVIATION made a nationwide survey of leading fixed basers. Collated here are their replies.

Horlick-Racine Airport shop at Racine, Wis., operated by Carlyle E. Godske of Racine Flying Service. Note floodlight for night landings, wide doors, and fireproof concrete block walls. Large, steel-frame windows provide plenty of light.

It was found that between 90 and 100 percent of those queried considered the following tools and equipment essential: Bench grinder, drill press, arbor press, spraying equipment with air compressor and tank, gas welding outfit, sewing machine, engine assembly stand (more than half advised making this item), bench vise, jigsaw (also used for filing), valve and valve seat grinder, set of box and socket wrenches, torque wrench, taps and dies, soldering equipment with gasoline blowtorch, plain reamers (and to a lesser degree, expansion reamers), steel tape 50 to 100 ft. long, files, micrometers, level and plumb line, electric hand drill, twist drills, weigh scale (one operator advised *three*), several jacks, cable splicing clamp, sparkplug tester, plenty of gluing clamps, a trouble lamp with several lengths of extension cord, and several fire extinguishers.

For toolmaking and similar work, 70 percent of those questioned said that a lathe with collet chucks and other attachments would be a great advantage. Granted, few considered the lathe absolutely essential, but many advised its purchase as soon as possible, feeling that the investment of several hundred dollars in this machine might be postponed for a few months when starting a new shop. The opinion was also expressed by many that the money saved by making small special tools with a lathe would eventually be greater than the cost of the machine.

Though several practical operators advised using the airplane itself as an engine test stand, over 50 percent considered a separate test stand necessary, and many of these noted that this was something which could very well be made in the shop.

Forge equipment, pressure greasing unit (as distinguished from the universal grease gun), circular saw table, hoist, rivet gun, surface plate, and battery charger drew votes from slightly more than half the total.

Trailing on the list, but specified as advisable later when business would justify the extra expenditure, were tire and tube vulcanizer, portable fuel and oil tanks with pump, glue mixer, magnet charger, bandsaw, Magnaflux, cylinder lapping or honing machine, and also the big five for sheet metal work—bench shear, squaring shear, cornice break, rolls, and beader.

By careful shopping and purchase of good second-hand materials when possible, this above equipment (except that mentioned in the last paragraph) should be acquired for between $2,300 and $2,500. Proposed by many was erection of a dope room with a ventilating system.

Choice of this last item depends more on climate than anything else; operators in some parts of the country —particularly dry, dust-free sections— claim that its use is advisable but not necessary. Apart from the cost of the structure, only expense would be for a good ventilating fan capable of changing the air as frequently as required by local health regulations.

Another practically indispensable item mentioned by everyone, is the parts-washing tank. This is often "home made". The tank itself can be almost any receptacle large enough. Regarding material for it, however, it is to be noted that aluminum is "allergic" to some cleansing solutions. The writer has seen an excellent washer made from two half barrels, the solution being heated in a metal container before pouring into the barrel. Being of wood, these tanks retained the heat —when covered—for several hours.

At an airfield where there are several fixed base establishments, the operators often make a mutual arrangement whereby each one purchases a piece of the less-frequently-employed or more expensive equipment, the use of which is paid for by the other operators whenever they require it. When each member of a group has a machine in this category, the arrangement is often similar to the old farm system of "trading work," making the actual cash outlay smaller.

Wood and metal propeller inspection and repair calls for considerable special equipment, much of which cannot be used for other work. For wood propellers a special bench and a balancing stand will be the only special equipment required, and with the exercise of a little ingenuity both of these can be fabricated in the shop.

For metal propellers the expenditure is considerable, because the much greater weights involved preclude the use of the lighter type of bench, etc. In addition, use of a Magnaflux is mandatory for testing steel parts, also a portable electric grinder should be purchased for surfacing the blades. Accordingly, it is not generally considered advisable for a small operator to tool up for this work until he definitely knows that the business will be there.

For re-covering with fabric, a large table is required for layout and cutting. This can be readily built of local lumber and covered with linoleum or thin sheet iron. Racks for stacking finished wings, control surfaces, etc., can be constructed in the shop.

SMALL TOWN AIRPORTS MUST FIT A BUDGET

By EDWARD E. THORP, *Assistant Editor, "Aviation"*

It certainly will be requisite that the small-community airport builder make every single dollar do its planned work—if the air-trade-nourishing future is to be realized. Hence specific attention is drawn to the well-gaged "Louisiana Plan," developed to enable lesser communities to lay out and operate practical municipal fields without financial over-extension.

THE PERTINENT SYSTEM evolved by the Aeronautics Div. of the state of Louisiana for developing a community's airport stage by stage has been hailed as a prime step in solving the problem of differing capacities and accommodations. For by this means, a community may build efficiently according to varied or changing needs, from minor traffic up to major—and still keep within a reasonable budget.

Provided is a complete airport at every stage in the construction, starting with a plain turf field of 120 acres and gradually adding to the original land, runways, and buildings until finally the community has a full size Class III airport with four 3,500-ft. runways and all improvements. This growth is planned in six stages, with none of the work done in the interim stages wasted or discarded. Each stage brings the airport further up the scale.

The accompanying diagrams illustrate graphically the details and economies of the "Louisiana Plan" for airport development. First stage is the sodded or turfed area, giving three landing strips about 2,600 ft. long, permitting landing in six directions.

Preliminary work would consist of purchase of 120 acres of land, grading and draining of the surface, and seeding of the landing strips. These operations should be performed with extreme care, because the efficiency of the later stages will depend to a great extent upon the accuracy of the grading done at this time. At this time the airport will rate Class I.

Second stage adds to length of strips up to maximum permitted by limits of the land. Two diagonal runways are graded, with taxiway and apron laid out in front of hangars. Runways are only 100 ft. wide, hence are permitted to be used for daylight landings only; but if made 150 ft. wide, night landings would be allowed. The airport has now become Class II, by addition of the above mentioned improvements to the former Class I field.

Stage III comprises grading of two more 2,500 ft. runways and building of several rows of T-hangars. The latter can be constructed at low cost. Assuming that good grading and drainage was done in Stage I and II, paving of the landing strips may proceed and should not be an expensive undertaking. This airport allows landings to be made in eight different directions, never more than 22½ deg. off the wind. Runways are suitable for landing smaller twin-engine planes such as are used for feederline operation. This airport should cover the initial requirements of towns up to 25,000 population, unless it is proposed to make the field a trunk airline stop.

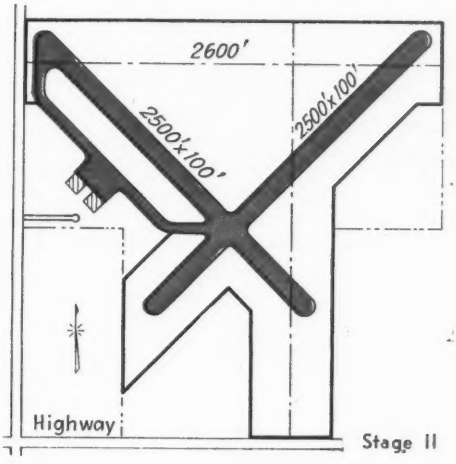
Stage IV calls for extension of the diagonal runways to 3,500 ft. in length for main airline operation, for which an additional taxiway must be built. Two plots of 20 acres each are required to square out the land. The driveway is completed for one-way traffic, and a small administration building is erected at the angle of the apron. Loading apron in front of administration building is also paved. The airport is now Class III, for day operation only, because of narrow—100 ft.—runways.

Fifth stage brings area up to 200 acres by addition of two 20-acre plots, enabling the third and fourth runways to be extended to 3,500 ft. Individual hangars are now erected, with paved apron in front. This airport is capable of handling business of cities up to 100,000 population.

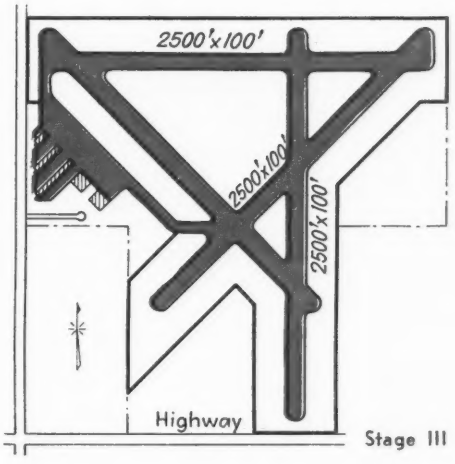
Stage IV assumes that night landings and heavy traffic will be the rule. Here, runways are to be widened to 150 ft. for after-dark landings, two hangars are to be added, and more paved taxiways are to be built to give access to the aprons from all directions. The administration building is now completed by addition of wings. Suitable for all but the large four-engine airliners, this airport will fill the needs of any except the greater cities.

By using the Louisiana Plan, any community which can afford to buy 120 acres of land can develop its airport at a minimum of cost. At any specific stage in the construction there will be a complete airport, suitable for immediate use and also for future improvement whenever conditions call for a field capable of handling heavier traffic.

Stage I

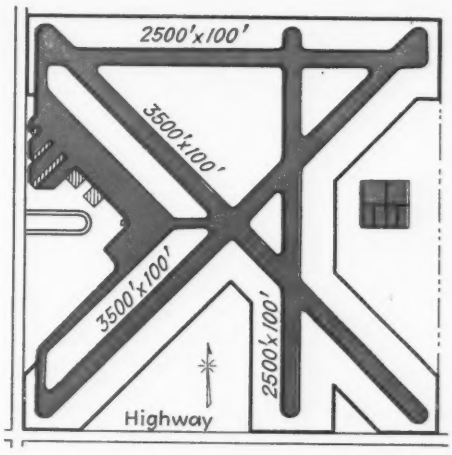


Stage II

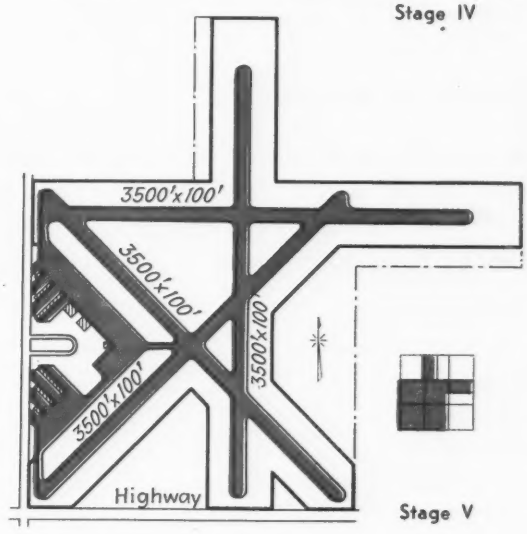


Stage III

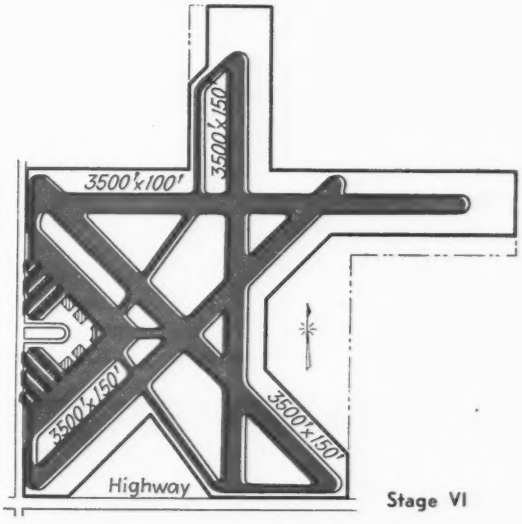
Development of a small airport. Stage I shows site of 120 acres, turfed and with small hangar and storehouse. Entrance road is at left. Landing or takeoff strips of 2,600 ft. in six directions are provided for. This forms a complete airport with unusual landing-strip lengths for its size. Stage II incorporates all previous work, with addition of south extension to landing strip and two paved runways with taxiway and apron. No additional land is required. Field can now be used for lighter types of commercial planes. Stage III shows addition of two more paved runways and individual hangars. By careful grading in Stage I the later cost of paving can be kept to a minimum.



Stage IV



Stage V



Stage VI

Stage IV calls for purchase of two additional 20-acre plots for extension of diagonal runways, giving landing facilities in eight directions. This provides field suitable for limited airline operation. Roadway of entrance drive is doubled. Stage V brings area up to 200 acres by addition of two 20-acre plots. All runways are now 3,500 ft. long, and more hangars have been added, also paved apron. Stage VI is maximum development advised for this type of airport. Administration building is completed at angle of apron, taxiways built and paved, and width of runways increased from 100 to 150 ft. Note that nothing added in any stage has been discarded and that of each stage the municipality has a complete airport.

Handy Calculator Simplifies Cruise Control

By THOMAS H. McCONNELL

To secure fullest economy and insure greatest safety on long distance flights, a practical cruise control procedure is a must. Operating like a slide rule, this device eliminates guess-or-graph methods by quickly hairlining all the fuel-stretch answers.

ONLY A FEW YEARS AGO some pilots thought the best way to get to their destination was to bend the throttle, or throttles, over the quadrant and pray. However, with the advent of World War II and consequent increase of long distance flights, need for really precise operation reached critical proportions. And so Army, Navy, and civilian airlines all turned their attention to advancing the art of cruise control to insure getting airplanes to their destination. Accordingly, much data was soon gathered.

Although of inestimable value, this data remained voluminous and difficult for the average pilot to understand. He could hardly be expected to fumble through a number of complicated graphs in order to learn if his controls were set for maximum range. Yet the variables were so many and the relationship between them so complicated that a simple means of presenting the data was hard to find.

This was the situation at the time when experimental investigation of this problem was undertaken by Curtiss-Wright engineers—Reginald Parry and the author, assisted by H. Lloyd Child, senior division test pilot, at Buffalo. Utilizing flight test data on the Curtiss C-46 Commando, work was started on a cruise control computer.

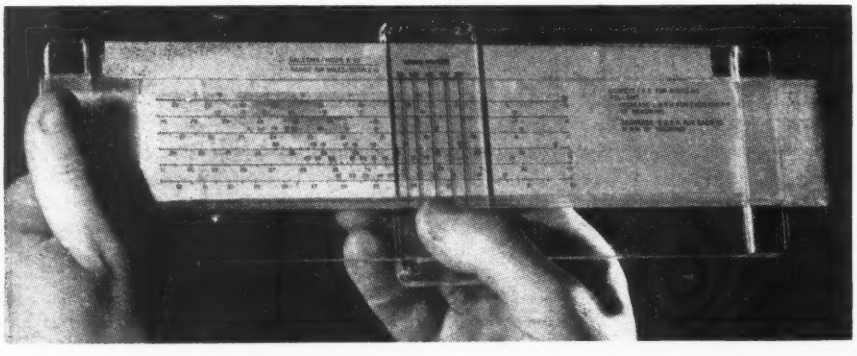
The experimental model developed is similar to a slide rule, but instead of having one hairline it has five for selected gross weights, covering a loading range from 39,000 to 50,000 lb., that is, the same gross weights at which original C-46 flight tests were run.

The rule has a sliding scale for computing density altitude. By setting the O.A.T. index against the pressure altitude on the left, a correct density altitude reading is obtained on the right. Then the sliding index (with the five hairlines) is moved over until the index line (also the 39,000-lb. line) is over the correct density altitude. At this setting it is only necessary to read down the correct weight line until the desired airspeed is intersected. Then readings are obtained for correct rpm., manifold pressure, and mixture and blower settings.

As implied, this original computer was designed for the Curtiss C-46, which has a two-speed direct gear driven impeller. On an airplane using turbosuperchargers the blower setting can be ignored, since this would be directly determined by manifold pressure demands.

On the reverse side of the computer, when the device is set as above, gasoline consumption in gph. may be read as well as true airspeed in air mph. Fuel consumption is read at the applicable gross weight, since gas consumption increases with weight. True airspeed, however, is always noted at the reference line (39,000-lb. line). A correction is provided for head or tail winds, and also a correction for application of carburetor heat.

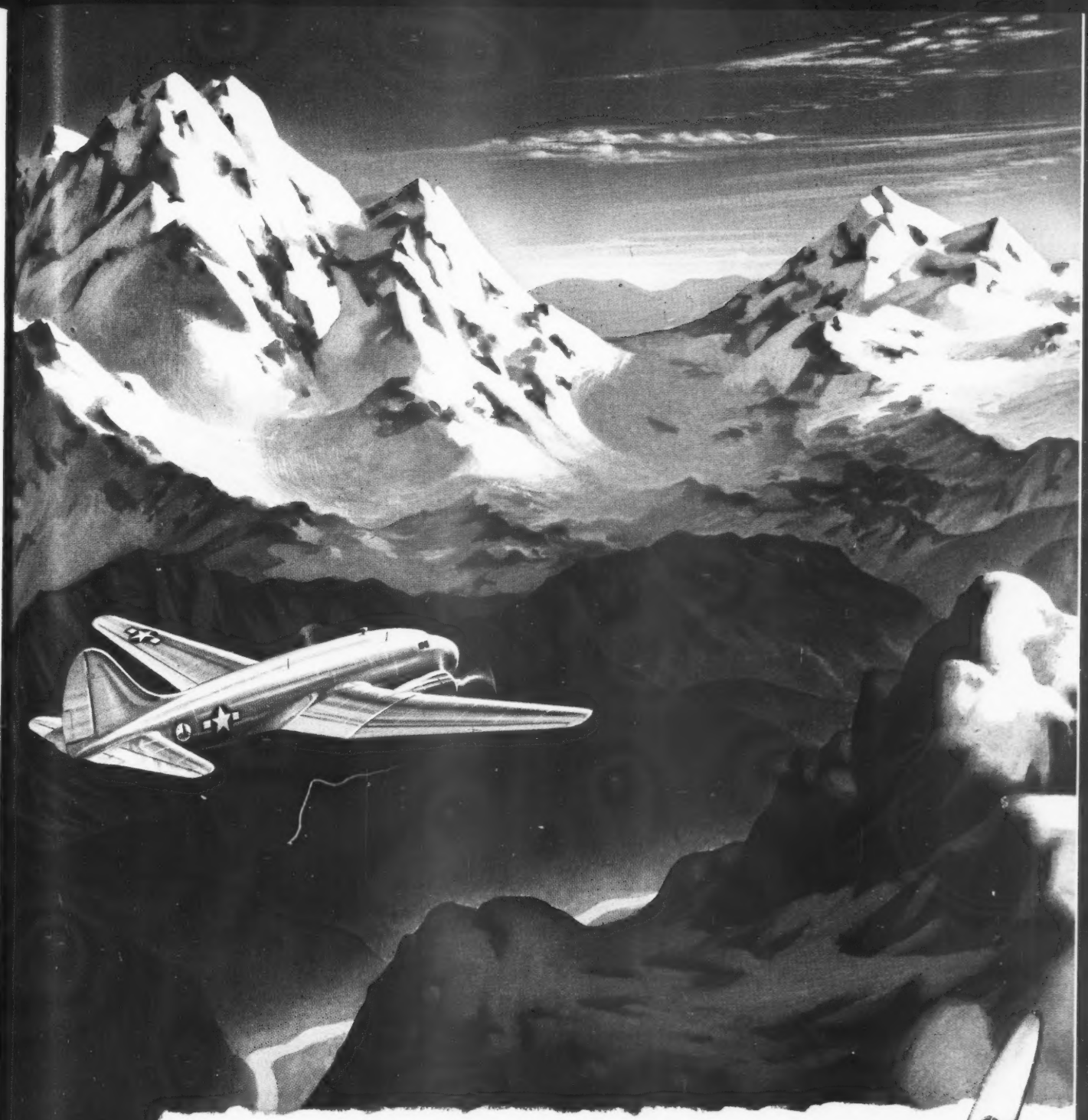
This computer is easily adaptable to any airplane, because the method used can be applied to any aircraft on which flight test data is available. In order to obtain single-engine computations it will only be necessary to remove the center slide, inscribe it with single-engine performance data, and then re-insert. The device can be of especial value when airplanes are operating at extreme limits of ranges. The computer has already been inspected at Wright Field, and it is being submitted to the Technical Data Section, Flight Division, for flight testing. Patent for the cruise control computer has been assigned to Curtiss-Wright Corp.



Original working model of computer. Performance data is so arranged that device operates like conventional slide rule. On this side, fuel consumption in gph. and true airspeed are read; reverse side gives density altitude, desired airspeed, rpm., manifold pressure, and mixture and blower settings.

Steps in Operation of Computer

1. Set O.A.T. opposite correct pressure altitude.
2. Real density altitude at right, opposite correct pressure altitude.
3. Set reference line (39,000-lb. line) on slide at correct density altitude.
4. Then read down correct weight line until desired airspeed is intersected.
5. At point of intersection note rpm. and color of section where intersection occurs.
6. Refer to key on left where color indicates mixture setting, blower setting, and whether operation is at full or partial throttle.
7. Without changing position of hairline slide, now turn computer over and read true airspeed and range in air mph. at intersection of reference line (39,000-lb. line) and bottom side of correct airspeed line.
8. Read fuel consumption in gph. at intersection of correct gross weight line and top side of correct airspeed line.



Hauling the Load over the HUMP

Air Transport Command operations in the China-Burma-India area have become a symbol of reliability and endurance, both of men and equipment—a reputation built on day-in, day-out, all-weather flying over the world's roughest terrain, often under attack. The performance of Curtiss Propellers on C-46 Commandos along this aerial Burma Road typifies their dependability in air transportation.

Curtiss-Wright Corporation, Propeller Division

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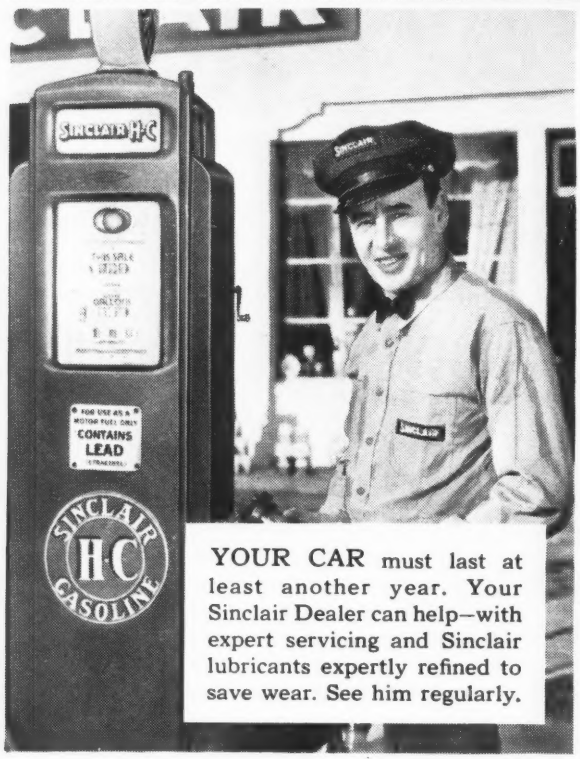

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Avigation Via Air Analysis*

By M. D. LOWENSTEIN, *Lieutenant, USNR*

With refinement of meteorological techniques, more reliable data on variations of air qualities will be available. And by utilizing this data, preflight planning and avigational procedure enroute can improve schedules and reduce hazards. Here's a new and pertinent treatment of how air analysis may be applied to these flight factors.

IT REQUIRES more than a few mechanical skills, pilot's seat sense, and a knowledge of conventional physics to best exploit, for flight purposes, the subtle balances attendant upon the laws of the atmosphere as it hugs the whirling globe. The preeminent importance of understanding the factors affecting equilibrium increases with the plane's speed and flight distance. The merest mutation in the air's qualities may have great significance for the avigator trained to interpret meteorological data.

A plane rides entirely free of earthly substances—rock, sand, water, forests, and cities—and, isolated in the huge mass of air, its flight leaves no wake, ruts, or other clues to betray the method or limitations of its progress. A practised, sensitive, meteorologically trained engineer is required to fully appreciate the nature of the peculiarly chaste, illusive phenomena of flight.

And if his observations are to be valid they must exceed the more obvious results pertaining to forecasting fronts and weather—especially so since these results are not everywhere unquestionably accepted as reliable. No doubt that, with the increase of weather-station distribution, not only will the immediately practical deductions from movements of fronts be refined, but this type of data may be replaced by conclusions reached through more intimate data and more recondite methods.

One of the most interesting achievements useful to avigators is the determination of drift by means of altitude corrections. The procedure, developed by John C. Bellamy, requires the taking of simultaneous readings on absolute and pressure altimeters at equal time intervals. Absolute altitudes are obtained with a special type of radio altimeter. A constant pressure altitude is maintained during the interval, and hence the plane flies on an isobaric surface.

Pressure altitude (it cannot be kept exactly constant) and absolute altitude are read simultaneously at the beginning and the end of the time interval and, with the aid of a simple equation, the difference between the second and first reading will give a component of the wind.

Assume that a plane, maintaining a constant pressure altitude, is flying in a direction which takes it from an area of high pressure to one of low pressure (Fig. 1). This alone would supply some information about the winds generated by the juxtaposition of these pressures. The accumulation of further data will define the wind more precisely.

In seeking to remain at a constant pressure altitude—where sea level pressure is assumed to be 1013.3 mb. or 29.92 in Hg., and the lapse rate is standard—the plane follows the slope of the isobaric surface. As the pressure in an area decreases, the plane must descend to higher pressures to keep the pressure altitude constant. If the plane is flying from (A) to (B), the greater the difference in pressure between (A) and (B) (indicated by the close grouping of the isobars), the greater will be the difference in absolute altitude at these points which have the same pressure altitude.

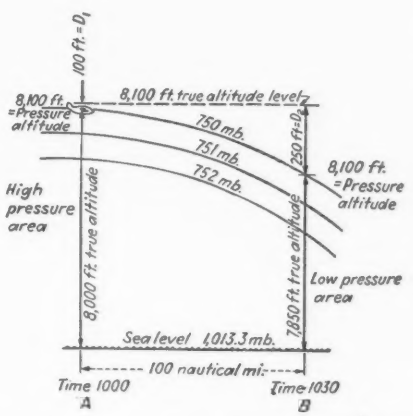


Fig. 1. Diagrammatic representation of plane flying an isobaric surface (constant pressure altitude=750 mb.).

Now, the geostrophic wind is a function of this horizontal pressure difference. A particle of air, subject to the gradient pressure, would follow a path normal to the isobars. Because of the modifying effect of Coriolis deflective acceleration, this path becomes parallel to the isobars. The wind is therefore a function of the closeness of the isobars, latitude (as it influences Coriolis), and to some degree, air density. Given these factors and a means of determining absolute altitude, the wind component perpendicular to the plane's heading can be computed.[1]

Assume that the latitude in which the plane (Fig. 1) is flying is 45 deg. north; TAS, 200 kt; and at time 1000, the plane is at (A) and the pressure altimeter reads 8,100 ft., while at the same instant the radio altimeter reads 8,000 ft. The pilot tries to keep the plane at approximately a constant pressure altitude, and at time 1030 the two altimeters are again read simultaneously. The pressure altimeter again reads 8,100 ft. and the radio altimeter reads 7,850 ft.

All the data necessary to compute a closely approximate geostrophic wind component normal to the plane's heading is now available. The slope of the isobaric surface is combined with Coriolis acceleration to determine the velocity of the component. It can be shown that:

$$C_n = g(D_2 - D_1) / 2\omega \sin l$$

where C_n is wind velocity in kt. in a direction perpendicular to the airplane heading; D_1 absolute altimeter reading minus pressure altimeter reading at first point—A in the example; D_2

* Opinions expressed herein do not necessarily reflect views of the Navy Department.

[1] M. M. Margules, Vienna, 1905, discussed the determination of wind velocity as the rearrangement of two contiguous air masses of different temperatures. His equation is $C = \frac{1}{2} \sqrt{gh\,(\Delta T/T_m)}$ in which C is wind velocity, g gravity, h height, T difference between mean temperature of the air masses, and T_m mean temperature (absolute) of the two air masses.

TABLES OF FACTORS K AND Y

K-FACTORS

Lat. Range, (deg.)	K	Lat. Range, (deg.)	K
18–20	66	34–38	36
20–22	60	38–43	33
22–25	54	43–50	30
25–28	48	50–55	27
28–31	44	55–70	25
31–34	40	70–90	22

Basic formula: $C_n = K\frac{(D_2 - D_1)}{X}$

C_n is component of wind *normal to true heading;* X is true air distance between observations (= TAS multiplied by fraction of an hour between observations).

Y-FACTORS (alternate method)

Lat. (deg.) / TAS (kt.)	25	30	35	40	45	50	55	60	65
140	7	8	9	10	11	12	13	14	14
160	9	10	12	13	15	16	17	18	19
170	10	12	13	15	16	18	19	20	21
180	11	13	15	17	18	20	21	23	24
190	12	15	17	19	21	22	24	25	26
220	17	20	22	25	28	30	32	34	35

These values are calculated for 1 hr. interval between observations. For smaller intervals, multiply the table value by the fraction of an hour between observations.

Example: For ½ hr. interval at 180 kt. and 50°, Y-factor is 10.

absolute altimeter reading minus pressure altimeter reading at second point, B; g gravity constant; ω angular velocity of earth; and l latitude of flight.

And if X represents nautical mi., obtained by taking TAS × fraction of hr. = distance; then, by inserting the values of all the constants:

$$C_n = 21.47\ (D_2 - D_1)\ /\ X \sin l$$

Making factor K vary with latitude, and combining with the constant:

$$C_n = K(D_2 - D_1)\ /\ X$$

Applying this equation to the example (Fig. 1) after selecting the value for K=30 from the accompanying tables:

$$D_1 = 8{,}000 - 8{,}100 = -100 \text{ ft.}$$
$$D_2 = 7{,}850 - 8{,}100 = -250 \text{ ft.}$$

Substituting in the equation:

$$C_n = \frac{30\ (-250 + 100)}{200/2} = (-)\ 45 \text{ kt.}$$

The negative sign here indicates that the plane is passing into an area of lower pressure. From this, the direction of the drift may be ascertained. Since it is known that the winds of a *low* in the northern hemisphere go counterclockwise, then, if a plane is entering the low, the wind must be from port, and the drift is right. Similarly, if $D_2 - D_1$ is positive, then the plane is entering a *high* where the wind is clockwise, hence from starboard, and the drift is left.

The wind component obtained from the equation $C_n = K\ (D_2 - D_1)/X$ may be plotted and used as described in application (3) below. It must be kept in mind that C_n is not the entire wind affecting the aircraft, but only the component normal to the heading. A component parallel to the heading, and from which a ground speed could be computed, cannot be determined by merely using this equation. However, there are several applications suggested for Bellamy's method:

(1) Solving for a drift angle, DA, instead of the wind vector—

If C_n is the vector perpendicular to the heading and X is the distance flown in a given time, then $C_n/X = \tan DA$, (Fig. 2).

Substituting the value $C_n = K(D_2 - D_1)/X$ in the equation $C_n/X = \tan DA$:

$$\frac{K\ (D_2 - D_1)/X}{X} = \tan DA$$

$$K\ (D_2 - D_1)\ X^2 = \tan DA$$

By setting up drift factors for K/X^2, such that $D_2 - D_1/Y = DA$, for various latitudes and over the range of the plane's airspeeds, the drift angle DA is very simply computed. The values of Y (accompanying table) supplied for 1 hr. intervals, may be reduced for any proportional part of the airspeed.

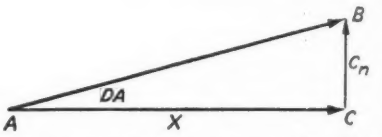
Applied to the example, Fig. 1: TAS = 200 kt.; latitude = 45 deg.; $D_2 - D_1$ = (−) 150; time, ½ hr.; and Y (from table) = 23.3. Therefore:

$$\frac{150}{23.3/2} = 13 \text{ deg. Right}$$

The drift is applied to the true heading to obtain the track. Again it is emphasized that the wind effect does not include the component parallel to the course. The ground speed, therefore, is indeterminate.

(2) Using the estimated ground speed instead of airspeed to compute the drift angle DA—

In addition to the normal wind component, C_n (Fig. 3), assume another wind component parallel to the heading such that the resultant of the two winds constitute the entire wind. Let the parallel component, H_2, in one instance, be the tailwind; and X the true airspeed factor. First consider the effect of only the normal, C_n, component; then angle CAB is the drift angle, AC being the X factor. Next, use the wind component H_2; the drift angle then becomes angle CAB_2; and $AC_2 = X + x_2$ now becomes the X factor. In another instance, if the parallel



X = Airspeed or ground speed (see Fig.3)
DA = Drift angle
C_n = Wind vector component

Fig. 2. Diagram showing wind component and drift angle derived from equations tan DA= C_n/X and DA=$(D_2-D)/Y$.

component is a headwind, H_1, the drift angle is CAB_1, and $AC_1 = X - x_1$ is the X factor.

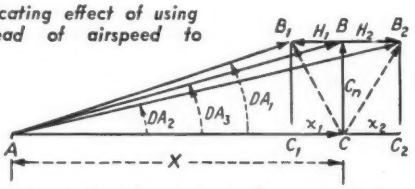
A drift angle obtained by correcting the X factor will be more accurate, even with an estimate ground speed, than if TAS is used. For high-speed aircraft, the effect of an error in estimating ground speed is small—as a study of Fig. 3 will reveal. A suggested form for tabulating data is shown in Fig. 4.

(3) Plotting the normal wind component, C_n, from the basic formula—A fix can be found if an LOP is combined with C_n. From the last fix, or EP (A, Fig. 5,) draw the true heading (length = TAS × time interval between fix and LOP). From the equation for C_n determine whether drift is to port or starboard (plane entering a higher or lower pressure area) and draw a line parallel to the heading at a distance from it equal to C_n × time interval. The intersection of this line and the LOP will give a good actual position, fix B. (See Fig. 4 for tabulating form.)

(4) Double drift procedure—

Two components of the geostrophic

Fig. 3. Diagram indicating effect of using ground speed instead of airspeed to derive drift angle.



AC = Airspeed = X; CB = Wind component (normal to heading) = C_n
H_1 = Wind component parallel to heading (headwind)
H_2 = Wind component parallel to heading (Tailwind)
DA_1, DA_2, DA_3 = Drift angles obtained from headwind, tailwind, and airspeed, respectively

wind at right angles to each other can be obtained by flying a "wind star." The vector sum of the components will be the true geostrophic wind speed and direction. The objection to this procedure is the time involved in flying off course.

In addition to obtaining the wind component in flight, pressure differentials may be used at meteorological stations to which they are radioed. Together with other data the information is combined and extrapolated to determine flight conditions for inaccessible areas. To forecast the pressure at a certain altitude, or to forecast a true altitude of a certain pressure altitude, requires a study of the relationships derived from a three-dimensional portion of the air. Constant altitude charts drawn from the above data for several levels are one source for this three-dimensional concept. The familiar synoptic chart for sea level is an example of these charts, which are also made for levels of 5,000 ft., 10,000 ft., and 20,000 ft.

The isobars on each of these constant altitude charts indicate the pressure distribution on a horizontal section cut through the atmosphere, parallel to sea level. A comparison of the charts at different levels furnishes the desired three-dimensional representation.

For example, if after 12-hr. there is a fall in pressure for one station at the 10,000-ft. level and the pressure at the 20,000-ft. level remains unchanged, the mass of air between these two levels must have undergone a change in density during the 12-hr. period. This air became lighter as indicated by the fall in pressure at 10,000 ft. and, therefore, the temperature must have increased. Account must be taken of the effect of temperature changes of this kind before a forecast of the pressure and true altitude relations are extrapolated.

The forecast's usefulness is limited by the accuracy to which the mean temperature of the air can be determined. It has been found that an error of 1 deg. C. will produce an error of approximately 0.4 percent in the calculated thickness of the air mass.

Constant altitude charts are not the only type used to derive the three-dimensional picture. Another type of chart—not very familiar to American avigators, but used extensively by the British and Russians—is the constant *pressure* chart. It possesses several advantages over the constant altitude chart. The meteorological data applies to an isobaric surface, not to sea level, or an arbitrary parallel level above it. Instead of isobars there are *contours* drawn at 100-ft. intervals.

1	2	3	4	5	6	7	8	9	10	11
Time G.C.T.	Position Lat.	Position Lon.	Radio Alt.	Press. Alt. (29.92)	D= 4-5	$D_2 - D_1$ (Algebraic)	Y or K	Approx. Drift C_n	Ground Speed (Estimated)	Drift Corr.
					D_1					
					D_2					
					D_1					
					D_2					
					D_1					
					D_2					
					D_1					
				Pressure reading of setting 29.92	Radio altimeter minus pressure altimeter (subtracted algebraically)	Difference at beginning and end of 30 min. or 1 hr. interval. Sign values signal when into high or low. If (+), into high; if (−), into low	Factor from accompanying tables	$\frac{D_2-D_1}{Y} = DA$ or $C_n = \frac{K(D_2-D_1)}{X}$	Correction to be applied for head or tailwind	Columns 9 and 10

Fig. 4. Suggested form for data used in drift computations by altitude differentials.

Highs and lows correspond to those of constant altitude charts. Using constant pressure charts, the geostrophic wind may be computed from $C = 35.5/n \sin l$, where C is expressed in kt., n is distance between successive 100-ft. contours and is measured in degrees of latitude, and l is latitude.

Among the problems which can be solved in flight by the avigator, if he has means of measuring pressure and true altitudes, is determination of sea level pressure at any position. Example:

(a) Read radio altimeter—8,000 ft.

(b) Read, at same time as (a), pressure altimeter when set at 29.92 in.—8,100 ft.

(c) Read ambient temperature—5 deg. C.

(d) Using computer, place pressure altitude (8,100 ft.) opposite temperature (5 deg.).

(e) Opposite true altitude (8,000 ft.) on outside scale of computer, read calibrated altitude on inside scale—7,850 ft.

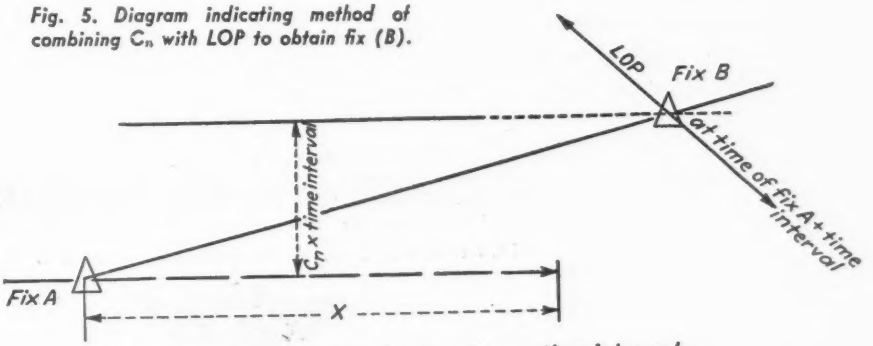
(f) Sea level pressure can be read on the altimeter setting dial—29.71 in.

Certain assumptions have been made in determining wind forecasted by pressure differentials, which do not exactly "square" with the facts. One is that the geostrophic wind is parallel to the isobars. This is rare, more usual situation being that the isobars are curved and the wind is not parallel to them. For example, the counterclockwise wind about a *low* (northern hemisphere) tends to blow toward the center of the area. A plane approaching a *low*, therefore, has the crosswind component (C_n) actually less than the theoretical one, and the parallel component (tailwind) greater than the theoretical.

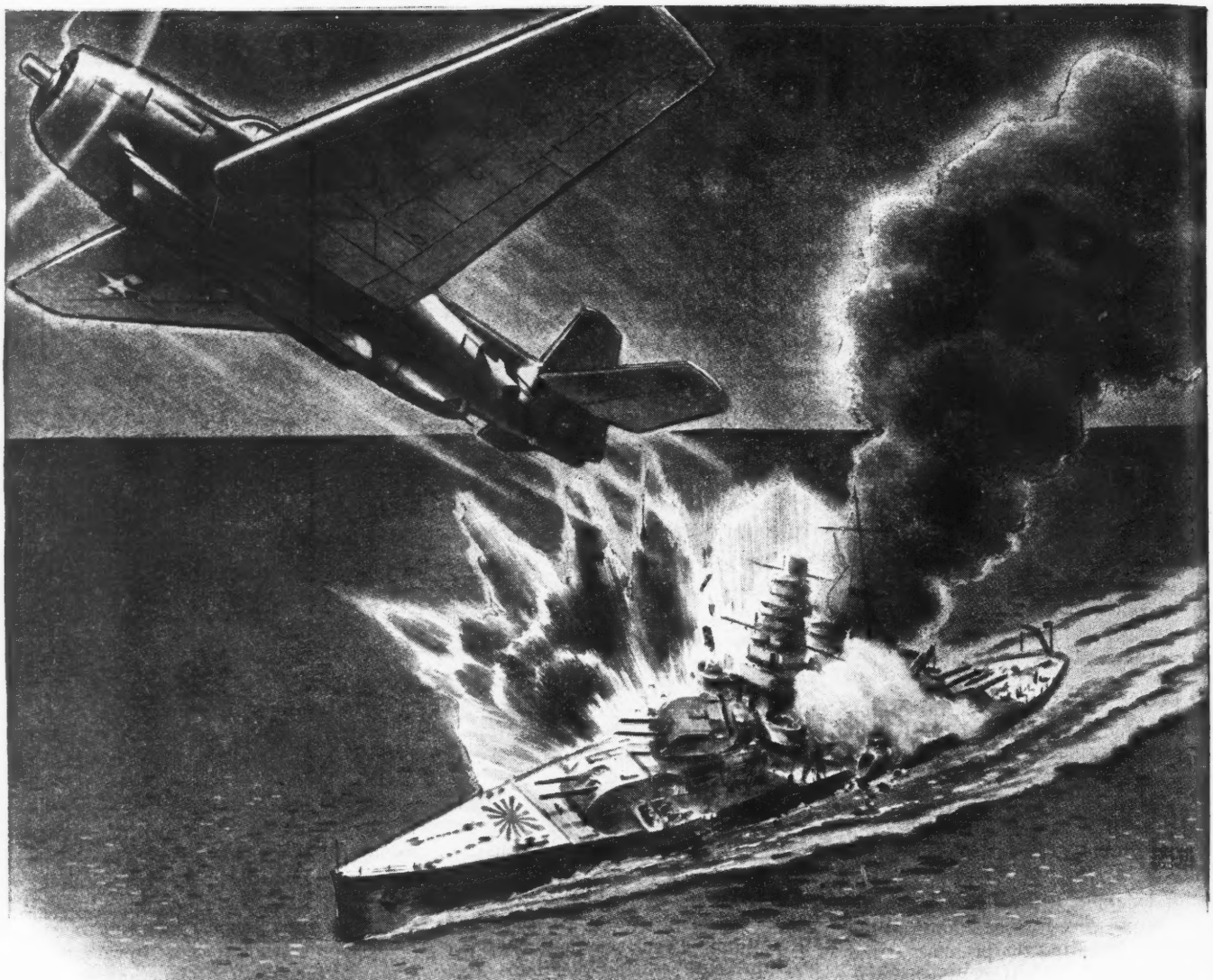
However, the differences between the geostrophic and the gradient (true) wind is small, and experience has shown that only a combination of low latitudes and isobars with small radii of curvature produce significant errors. Around high pressure areas, the isobars usually have large radii of curvature, and thus, geostrophic and

(*Turn to page* 303)

Fig. 5. Diagram indicating method of combining C_n with LOP to obtain fix (B).



C_n = Wind component normal to heading x time interval
X = True heading direction, TAS x time interval
Time interval = Time between fix A and LOP



C.A.B. FUNGICIDAL BRUSHING PRIMER

ALWAYS ON TARGET!

Roxalin's C.A.B. Fungicidal Brushing Primer No. 3350 makes it a simple matter for Naval contractors to comply with the recent Navy Process Specification making rot-proofing of aircraft fabric mandatory.

The exact required amount of Zinc Naphthenate is added to ready-mixed AN-D-1 Dope under the supervision of the same technicians who developed Emycel, the fabric finish that first utilized this fungicidal principle. Their watchful care makes sure that there is no excess of the fungicide to affect tautening properties of the dope or adhesion of the overlying top coats. Correct brushing viscosity is assured for trouble-free application.

Contractors can thus eliminate measuring and troublesome mixing operations and prevent the chance of error in arriving at the specified mixture in their plants.

In addition, a color indicator in Roxalin C.A.B. Primer No. 3350 shows that the specified process has been followed.

This product of Roxalin engineering has been developed and is made available to you with the approval of the Bureau of Aeronautics. Write to Department 805 for detailed information.

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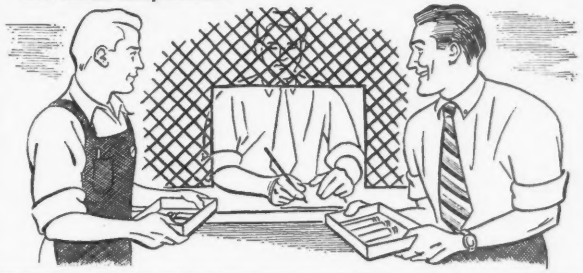
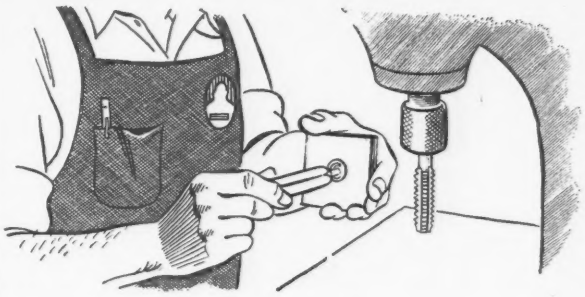
WATCH ROXALIN IN AVIATION

NOTHING WRONG WITH "REJECTED" PARTS? "GREENFIELD MAN" SOLVES GAGING MYSTERY

[A GTD SHOW-HOW REPORT]

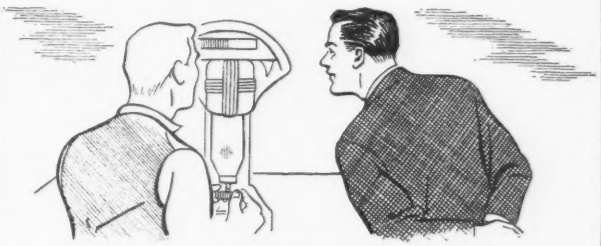
1 Customer ordered six 1/2-20 "Go" plug thread gages made to "X" pitch diameter tolerances. Three of them were assigned to machine operators as working gages and three to inspection department for final inspection.





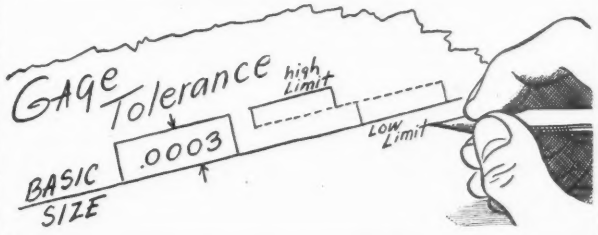
2 At tapping job the machine operators used working gages to check each part before they went on to next operation.

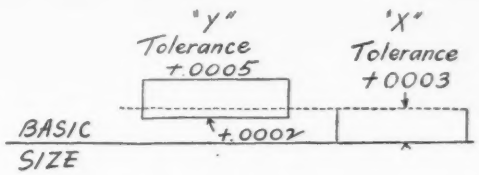
3 But at the final inspection of part, a large proportion of pieces failed to pass "Go" plug gage. Why? Actual measurement of rejected parts showed them to be "OK". Something was wrong. A hurry call was put in for "Greenfield Man".



4 On arrival at plant, "Greenfield Man" first had all six gages measured in customer's own inspection department, and found them all within tolerance.

5 "I'll show you what happened," said "The Greenfield Man". "Although all six gages were within specified limits, some were on the 'high side' and some on 'low side'. Thus high limit gages failed to enter where low limit gages would."





6 He then showed how this problem could be remedied by: 1. Measuring all gages and distributing those that tended to the "high limit" to machine operators and those tending to the "low limit" to the inspection department. 2. By ordering "Y" tolerance for working gages, and "X" tolerance for inspection gages.

Results: (1) Customer learned that trouble was not with gages he ordered, but with their application to the job. (2) Was able to establish proper gage ordering and handling procedures.

"Greenfield" SHOW-HOW is KNOW-HOW in action!

ON THREADING PROBLEMS SIMPLY CALL YOUR "GREENFIELD MAN" THROUGH YOUR "GREENFIELD" DISTRIBUTOR!

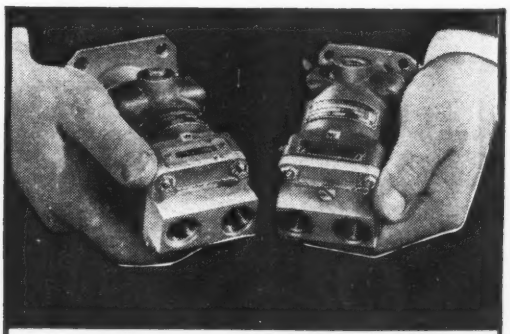
GREENFIELD TAP and DIE CORPORATION
GREENFIELD • MASSACHUSETTS

COAST GUARD'S HYDRAULIC Rescue Hoist

. . . engineered and built by VICKERS

This Sikorsky Helicopter equipped with a Vickers Hydraulic Rescue Hoist is used for rescuing personnel from the water or any other inaccessible place. Here is an application that well illustrates many of the important advantages of Vickers Hydraulic Power and Control.

The Vickers hydraulic motor for driving the winch has the high starting torque necessary. It will hold without clutches or brakes and can be stalled indefinitely without damage. It has easily controllable variable speed and smooth operation. It has instant starting, stopping or reversal due to very low inertia of the moving parts. It has simplicity of design and installation. It is rugged and dependable yet has minimum weight. These are all characteristics extremely useful on many other aircraft applications.



VICKERS AIRCRAFT PISTON TYPE HYDRAULIC PUMP AND MOTOR are the heart of the Hydraulic Rescue Hoist. Their overall efficiency and horsepower/weight ratio are exceptionally high; they occupy little space. A wide range of models is available.

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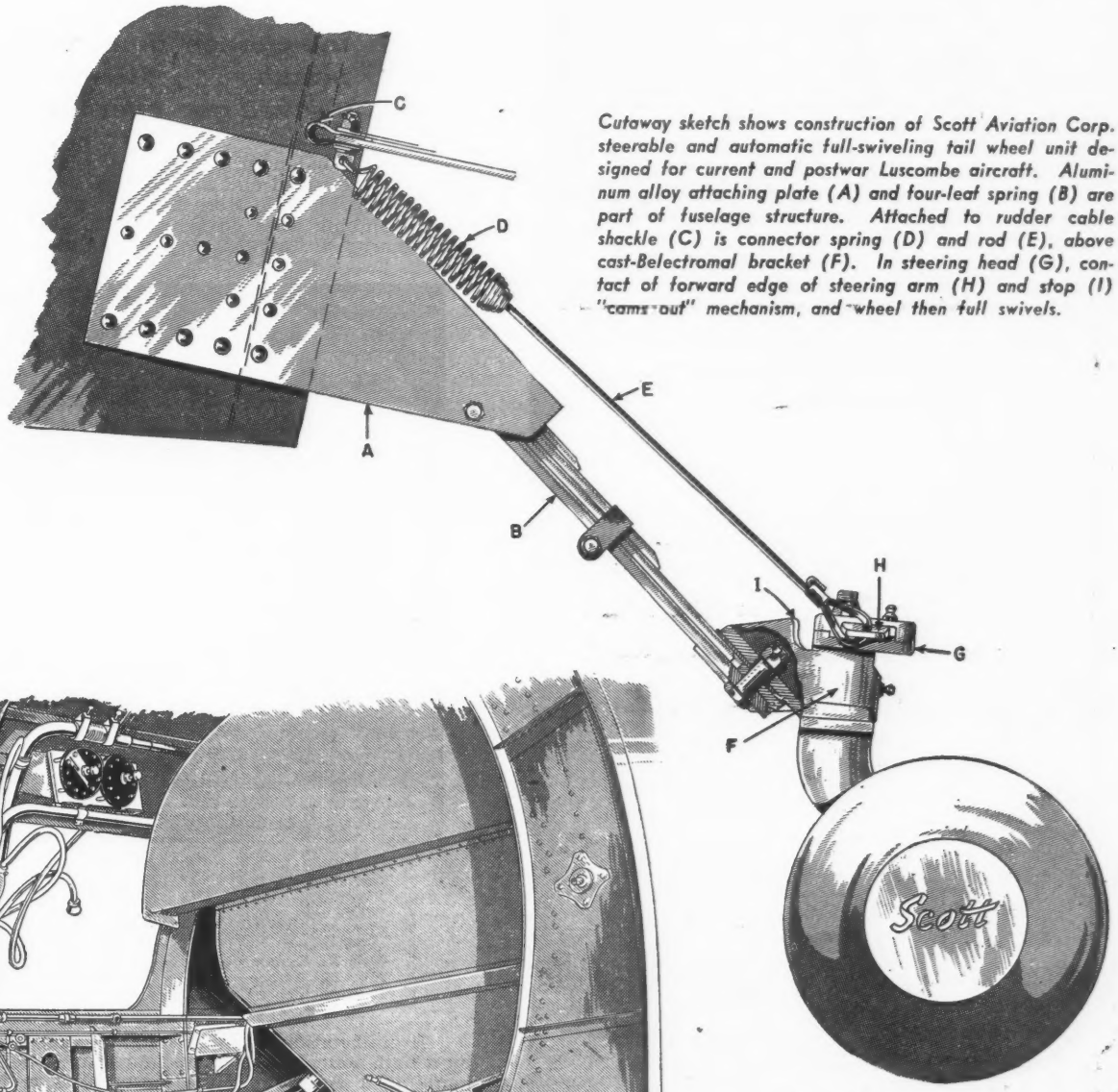
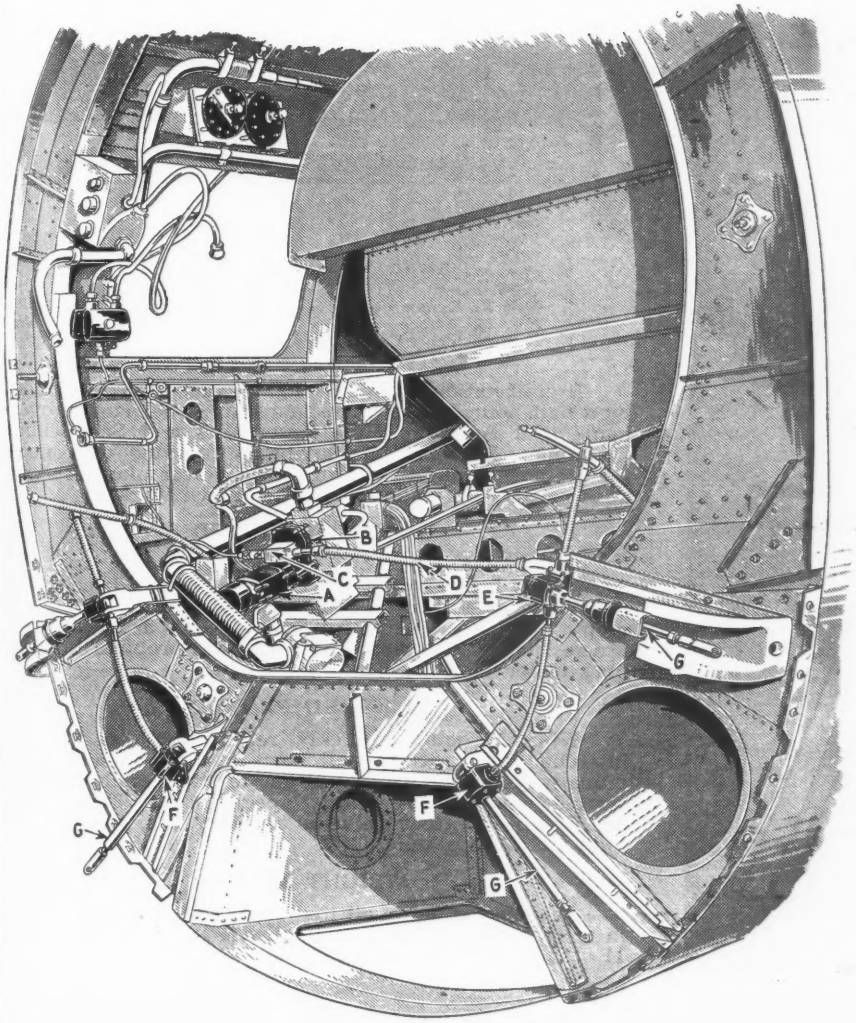
AVIATION'S SKETCHBOOK OF DESIGN DETAIL



Cutaway sketch shows construction of Scott Aviation Corp. steerable and automatic full-swiveling tail wheel unit designed for current and postwar Luscombe aircraft. Aluminum alloy attaching plate (A) and four-leaf spring (B) are part of fuselage structure. Attached to rudder cable shackle (C) is connector spring (D) and rod (E), above cast-Belectromal bracket (F). In steering head (G), contact of forward edge of steering arm (H) and stop (I) "cams out" mechanism, and wheel then full swivels.

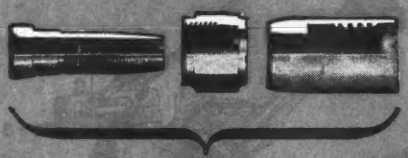


Lear cowl-flap actuating system on Boeing B-29 Superfortresses includes electric motor (A) supplying power through gear box (B) and drive unit (C), which transmits power through flexible cables such as (D) to "T"-type drives (E) and "L"-type (F), which operate screwjacks (G) attached to flaps for extension or retraction.

TWO MAJOR WAR DEVELOPMENTS

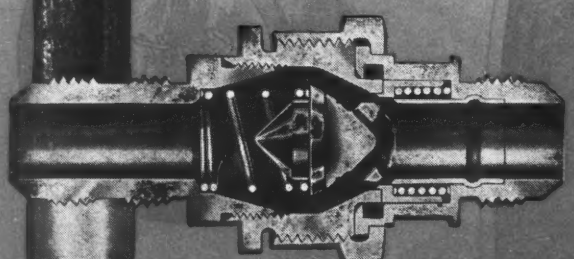
now ready for industry

1. Aeroquip Hose Lines* with detachable and reusable fittings simplify the supply problem and save valuable time, thus helping our armed forces on all fronts.



3 PIECES (each replaceable)

Assembly without special tools. No tightening or adjustment after assembly. Fittings can be removed from hose and reused over 100 times.



2. Aeroquip Self Sealing Couplings* allow disconnection of liquid carrying lines without loss of fluid and reconnection without inclusion of air.

*STANDARD EQUIPMENT ON U. S. ARMY AND NAVY COMBAT AIRCRAFT

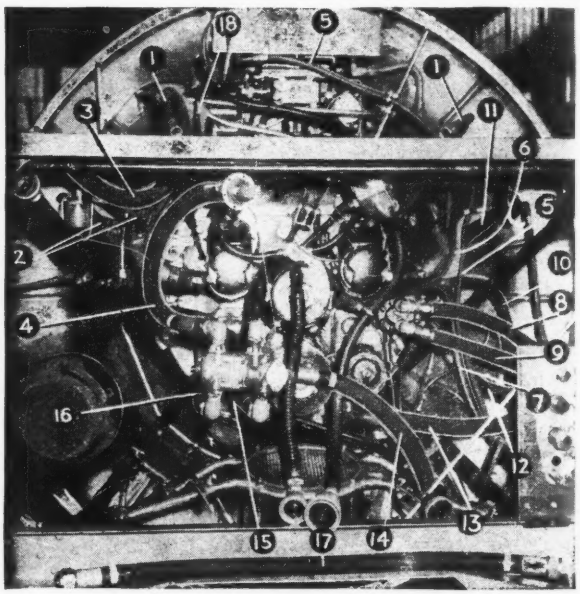
AEROQUIP CORPORATION

JACKSON, MICHIGAN, U. S. A.

5,061 HOURS OPERATION ON NEW BRANIFF INSTALLATION

Engine-change time shortened 30 minutes . . . 40 man-hours saved per overhaul.

With a 5,061-hour operational record revealing new gains in time saved and fire hazards reduced, installation of Aeroquip Flexible Hose Lines in place of rigid power plant plumbing lines on Douglas DC-3's by Braniff Airways marks a forward step in maintenance efficiency



1. *Oil Vent Lines*
2. *Dehydrator*
3. *Prop Feathering*
4. *Oil Suction.*
5. *Carb. De-icer*
6. *Oil Pressure*
7. *Manifold Pressure*
8. *Hydraulic Suction*
9. *Hydraulic Pressure*
10. *Fuel Cross Feed*
11. *Fuel Line*
12. *Fuel Suction*
13. *Vac. Suction*
14. *Oil Line to Cooler*
15. *Oil Line Out from Engine*
16. *Oil Line Into Engine*
17. *Oil Line Return to Tank from Cooler*
18. *Primer Line*

Braniff officials report engine-change time reduced by a half-hour, and 40 man-hours saved per engine overhaul, with Aeroquip Hose Assemblies and Self-Sealing Couplings. Further time saving is reported on regular service checks due to cleanliness of power plant sections, absence of leaks minimizing wash-down work.

SAFETY IMPROVED

By elimination of 50% of the pipe joints, and with Aeroquip's leak-proof performance stopping drips in the engine nacelles, fire hazards are measurably cut. Aeroquip's assemblies meet CAA requirements as to sufficient fire resistance. The flexibility also ends problems of rigid lines under vibration.

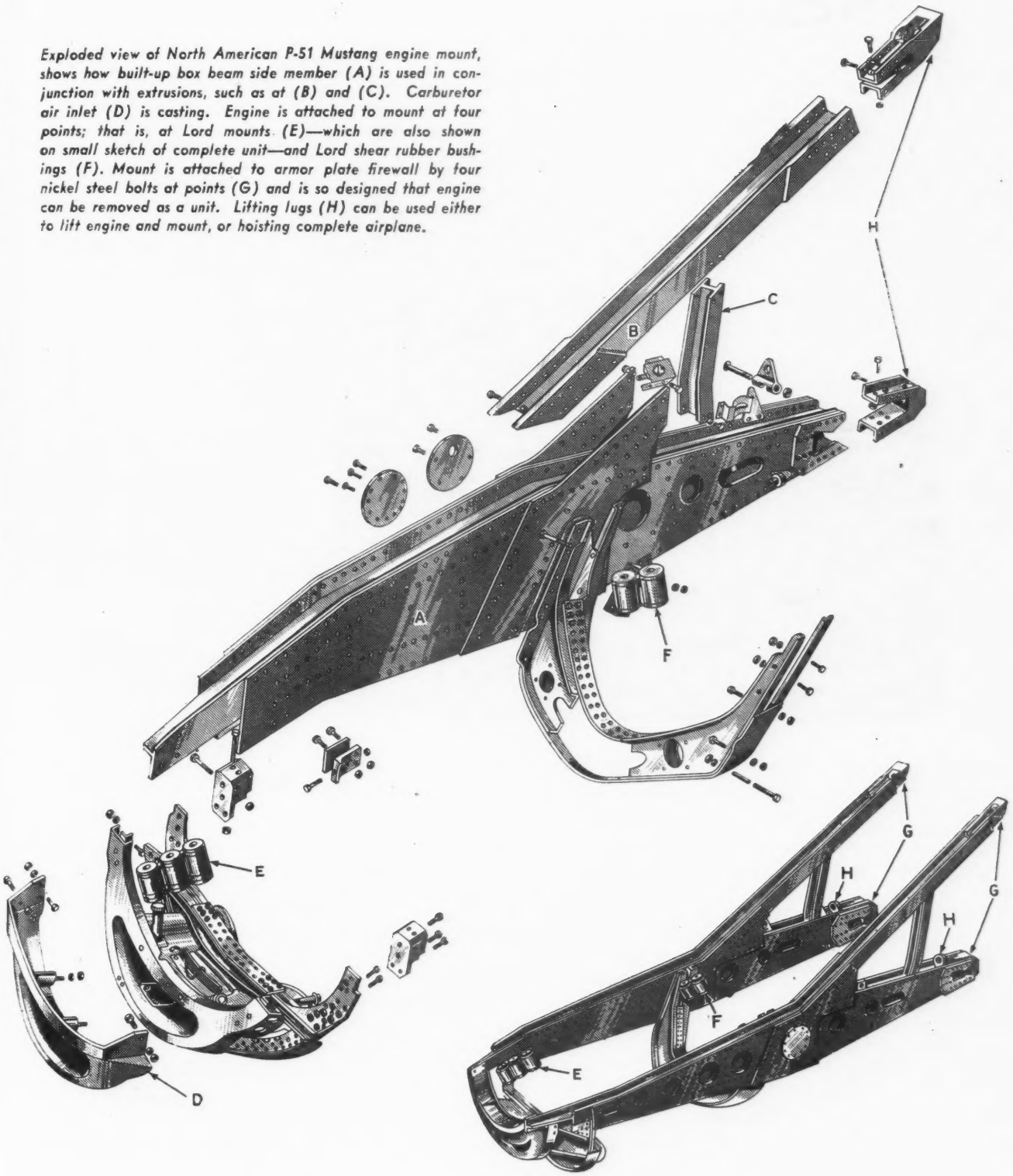
STOCK SIMPLIFIED

With Aeroquip's quickly removable, reusable and interchangeable fittings, all parts can be replaced individually and new hose lines cut to any lengths and assembled on the spot without special tools. This feature has proved of great value in military use, where these lines are "AN" standard.

WEIGHT SAVED

Aeroquip supplies all these advantages at no sacrifice in weight; in fact, savings totalled 4 lbs. 9 oz. and 4 lbs. 11 oz. for left and right engines.

Exploded view of North American P-51 Mustang engine mount, shows how built-up box beam side member (A) is used in conjunction with extrusions, such as at (B) and (C). Carburetor air inlet (D) is casting. Engine is attached to mount at four points; that is, at Lord mounts (E)—which are also shown on small sketch of complete unit—and Lord shear rubber bushings (F). Mount is attached to armor plate firewall by four nickel steel bolts at points (G) and is so designed that engine can be removed as a unit. Lifting lugs (H) can be used either to lift engine and mount, or hoisting complete airplane.



THE 25-AMP SWITCHETTE

"Big" brother of our little 10-amp Switchette

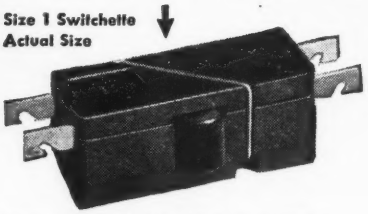
THIS new form of G-E Switchette is suitable for a wide variety of limit-switch and other aircraft control applications where space is limited and long life is required.

This new (Size 2) Switchette is rated 25 amperes at 24 volts d-c (115 volts a-c). It has screw-type terminals for easy wiring, and is completely enclosed for protection from dust.

Three contact arrangements are available: single-circuit, normally closed; single-circuit, normally open; and two-circuit. These Switchettes are suitable for use at altitudes up to 50,000 feet, and in temperatures from 93.5 C to minus 56.6 C. They resist corrosion and high physical shock and vibration, and are designed to withstand millions of mechanical operations.

Approximate dimensions are 2 by 1⅜ by 1 inch; approximate weight is 2 ounces. Ask your local office for Bulletin GEA-4259, which gives dimensions and complete description. *General Electric Company, Schenectady 5, N. Y.*

Size 1 Switchette
Actual Size



AND DON'T FORGET

We also have more than 200 forms of the original (Size 1) Switchette, as well as a variety of compact limit switches, transfer and selector switches, and other control devices built around this tiny contact mechanism. The Size 1 Switchette is rated 10 amperes at 24 volts d-c, and its dimensions are 1¼ by ½ by ½ inch. Bulletin GEA-3818 gives complete specifications and dimensions.

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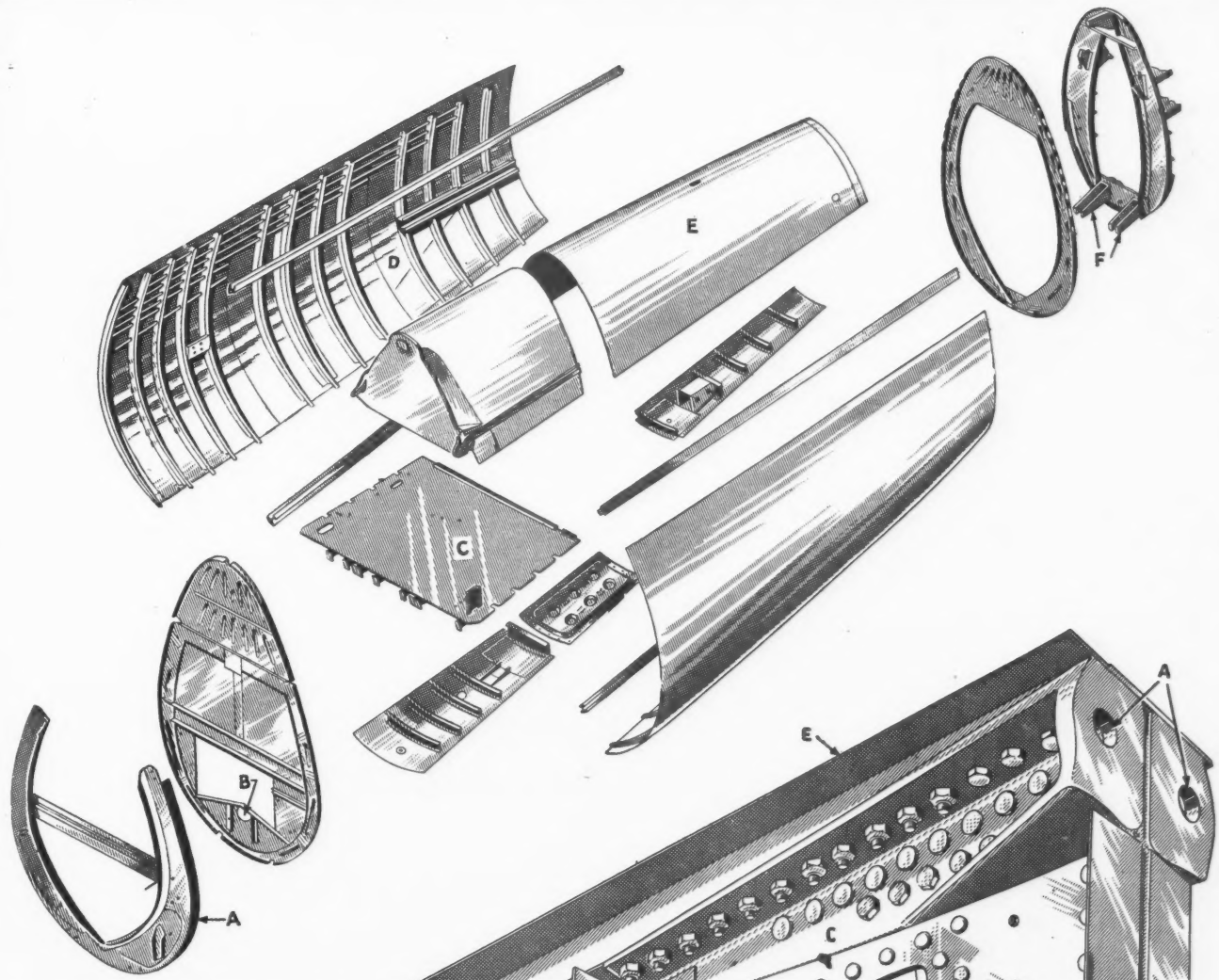
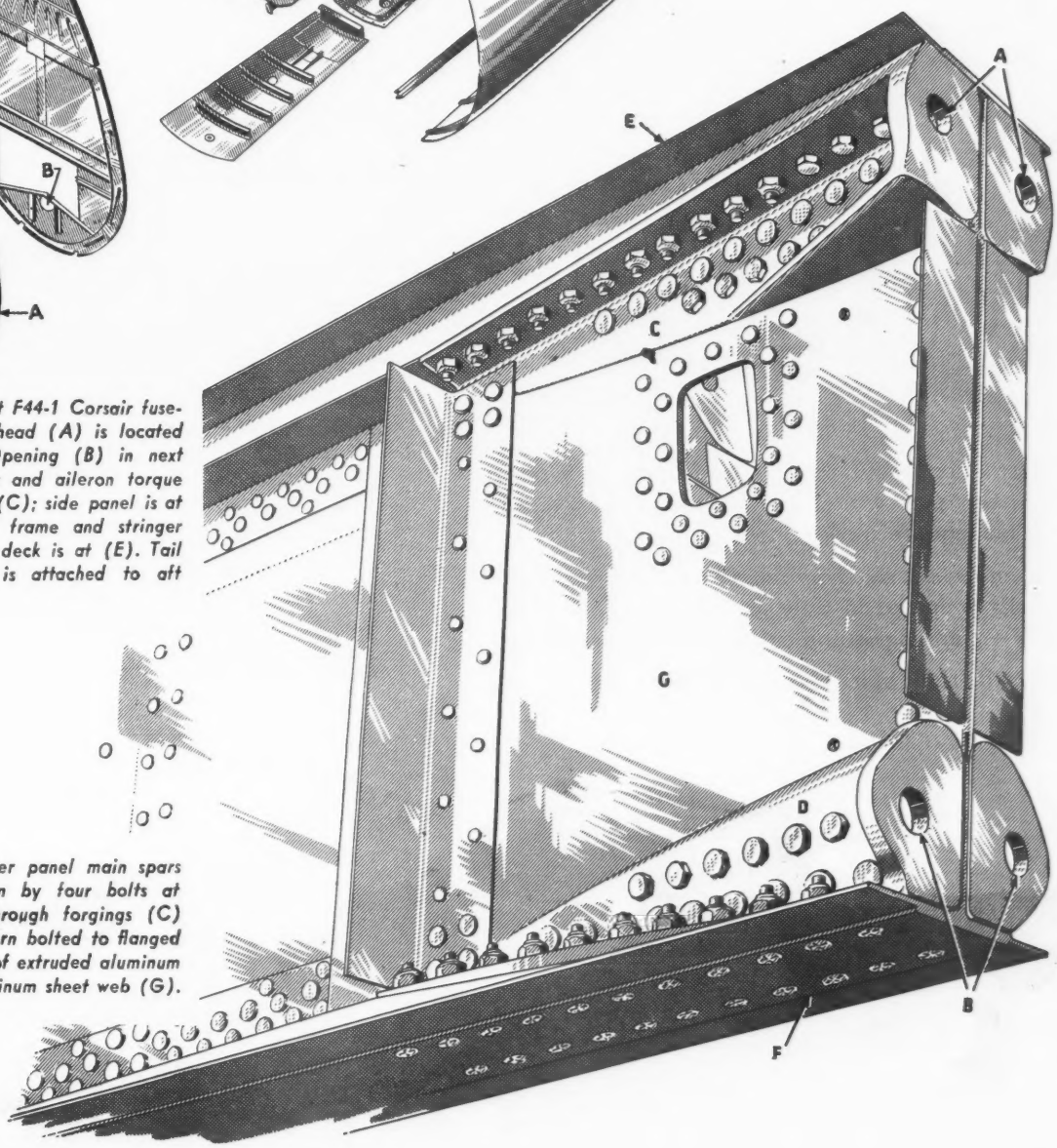


Exploded view of Vought F44-1 Corsair fuselage mid section. Bulkhead (A) is located just aft of cockpit. Opening (B) in next bulkhead is for elevator and aileron torque tube. Radio deck is at (C); side panel is at (D) and shows typical frame and stringer construction; and turtle deck is at (E). Tail wheel drag yoke (F) is attached to aft bulkhead.



Bell P-39 Airacobra outer panel main spars attach to center section by four bolts at points (A) and (B) through forgings (C) and (D), which are in turn bolted to flanged cap-strips (E) and (F), of extruded aluminum shapes and to solid aluminum sheet web (G).

Away On Vacation Back In November

Winter's gone—but it can't be forgotten! Worst in years, this past winter proved crippling to airports with inadequate snow removal equipment.

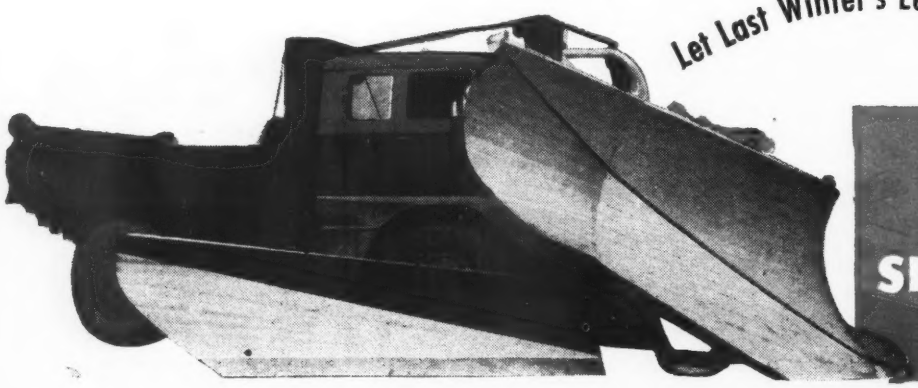
Remember—in six short months, winter returns. To be fully prepared in time, you've got to start right NOW—planning equipment needs and ordering early!

Make the right start by ordering the most outstanding of all snow removal equipment—Walter Snow Fighters . . . the trucks that do the "impossible" in snow clearance according to highway and airport officials. Specially engineered, and featuring the exclusive 4-Point Positive Drive, Walter Snow Fighters give you a combination of great power—traction—speed—and ruggedness found in no other truck.

To keep ahead of the blizzards next winter—ready to fly when the snow stops—equip with Walter Snow Fighters. Act now, by writing for detailed literature.

WALTER MOTOR TRUCK CO., 1001-19 Irving Ave., Ridgewood 27, Queens, L. I., N.Y.

Let Last Winter's Lesson be Next Winter's Warning!



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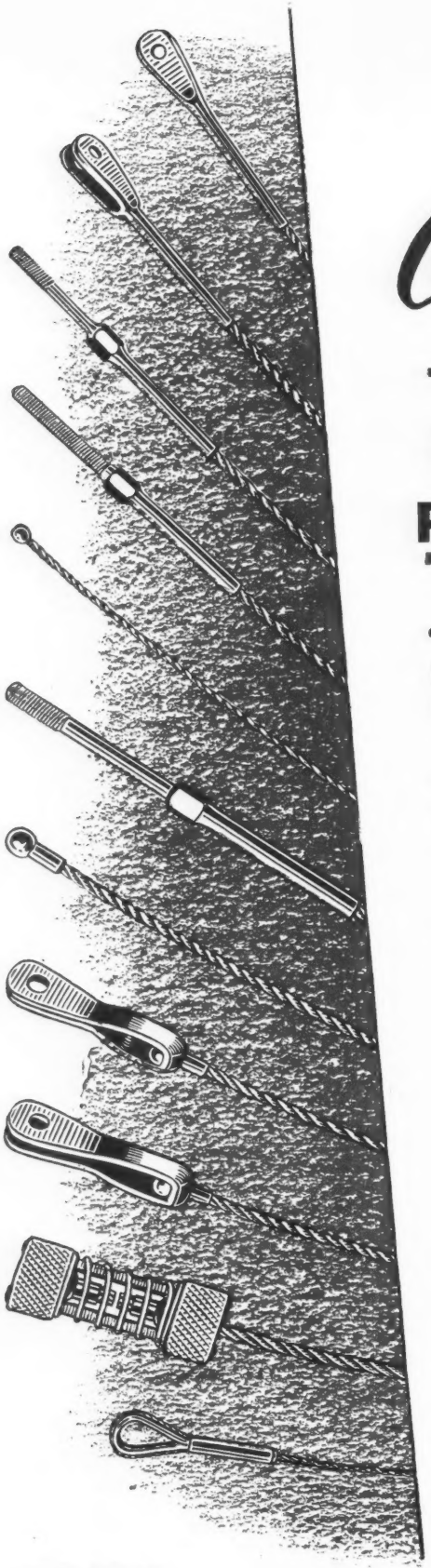
SHEET NUMBER . . . D-26 (cont'd from April)
CLASSIFICATION . . Materials
SUB CLASSIFICATION . Ball & Roller Bearings

Standard Dimensions and Tolerances

For taper roller bearings Type TS

TAPER ROLLER BEARINGS - TYPE TS

BEARING NUMBER	BORE	O.D.	BRG. WIDTH	CONE RADIUS	CUP RAD.	BEARING NUMBER	BORE	O.D.	BRG. WIDTH	CONE RADIUS	CUP RAD.	BEARING NUMBER	BORE	O.D.	BRG. WIDTH	CONE RADIUS	CUP RAD.
A8037-A2126	.3750	1.2959	.3940	3/64	3/64	28181-28315	1.5000	3.1495	.8270	9/64	1/16	6280-6220	2.1250	5.0000	2.0000	9/64	1/8
A2047-A2126	.4720	1.2959	.3940	1/32	1/64	337-332	1.5000	3.1496	.8268	1/32	3/64	636-632	2.1250	5.3750	1.6250	9/64	1/8
A4050-A4138	.5000	1.3775	.4330	3/64	1/64	3381-3320	1.5000	3.1562	1.1563	9/64	1/8	385-382	2.1653	5.8750	.8268	1/32	1/32
A4059-A4138	.5900	1.3775	.4330	1/32	1/64	3876-3820	1.5000	3.3750	1.1875	9/64	1/8	389-382	2.1850	5.8750	.8268	1/32	1/32
A6062-A6157	.6250	1.5745	.4730	3/64	1/64	418-414	1.5000	3.4843	1.0625	9/64	1/32	28682-28622	2.2500	5.8437	.9688	9/64	1/32
17580-17520	.6250	1.6875	.6563	1/16	1/16	49150-49368	1.5000	5.6875	1.2500	9/64	1/8	387A-382	2.2500	5.8750	.8268	9/64	1/32
05062-05185	.6250	1.8504	.5662	1/16	3/64	444-432	1.5000	3.7500	1.0938	9/64	3/32	462-453X	2.2500	4.1250	1.1875	3/32	1/8
09062-09196	.6250	1.9380	.9063	1/32	1/16	542-532X	1.5000	4.2500	1.4375	9/64	1/8	390-394A	2.2500	4.3307	.8661	3/32	1/32
A6067-A6157	.6690	1.5745	.4730	1/32	1/64	26881-26820	1.5625	3.1562	1.0000	9/64	1/8	3979-3920	2.2500	4.4375	1.1875	9/64	1/8
A6075-A6157	.7500	1.5745	.4730	.040	1/64	3382-3320	1.5625	3.1562	1.1563	9/64	1/8	623-612	2.2500	4.7500	1.6250	9/64	1/8
05075-05185	.7500	1.8504	.5662	3/64	3/64	422-414	1.5625	3.4843	1.0625	9/64	1/32	5558-552A	2.2500	4.8750	1.5000	9/64	1/8
09078-09196	.7500	1.9380	.9063	3/64	1/16							65228-65500	2.2500	5.0000	1.7500	9/64	1/8
1775-1729	.7500	2.2400	.7625	1/16	3/64	28188-28315	1.5748	3.1495	.8270	1/16	1/16	6375-6320	2.2500	5.3447	2.1250	11/64	1/8
05079-05185	.7870	1.8504	.5662	1/16	3/64	344-332	1.5748	3.1496	.8268	9/64	3/64	29582-29520	2.3622	4.2500	1.0000	1/32	1/8
07079-07204	.7874	2.0470	.5910	1/16	1/64	420-414	1.5748	3.4843	1.0625	9/64	1/32	397-394A	2.3622	4.3307	.8661	1/32	1/64
12580-12520	.8125	1.9380	.7813	1/16	1/16	24780-24720	1.6250	3.0000	.8750	9/64	1/32	28985-28920	2.3750	4.0000	1.0000	9/64	1/8
07087-07204	.8750	2.0470	.5910	3/64	1/64	11162-11315	1.6250	3.1495	.7090	1/16	1/16	3980-3920	2.3750	4.4375	1.1875	9/64	1/8
1380-1329	.8750	2.1250	.7625	1/16	1/16	342-332	1.6250	3.1496	.8268	9/64	3/64	6376-6320	2.3750	5.3447	2.1250	9/64	1/8
1755-1729	.8750	2.2400	.7625	3/64	3/64	28682-28620	1.6250	3.1562	1.0000	9/64	1/8	39250-39412	2.5000	4.1250	.8438	.060	.060
1280-1220	.8750	2.2500	.8750	1/32	1/16	3877-3820	1.6250	3.3750	1.1875	9/64	1/8	395-394A	2.5000	4.3307	.8661	9/64	3/64
1779-1729	.9375	2.2400	.7625	1/32	3/64	3577-3525	1.6250	3.4375	1.1875	9/64	1/8	3982-3920	2.5000	4.4375	1.1875	9/64	1/8
3659-3620	.9375	2.4375	1.1250	3/32	1/8	419-414	1.6250	3.4843	1.0625	9/64	1/32	33251-33462	2.5000	4.6250	1.1875	1/32	1/8
2685-2631	.9375	2.6150	.9375	1/32	1/64	4388-4335	1.6250	3.5625	1.5625	9/64	1/8	477-472A	2.5000	4.7244	1.1418	1/32	1/8
26093-26263	.9375	2.8345	.7480	3/32	1/16	49162-49368	1.6250	5.6875	1.2500	9/64	1/8						
07096-07204	.9635	2.0470	.5910	1/16	3/64	46162-46368	1.6250	5.6875	1.2500	1/32	1/8	5584-5535	2.5000	4.8125	1.7188	9/64	1/8
07100-07204	1.0000	2.0470	.5910	.040	1/64	447-432	1.6250	3.7500	1.0938	9/64	3/32	559-552A	2.5000	4.8750	1.5000	9/64	1/8
15578-15520	1.0000	2.2500	.6875	3/64	1/16	526-522	1.6250	4.0000	1.3750	9/64	1/8	565-563	2.5000	5.0000	1.4375	9/64	1/8
1986-1932	1.0000	2.3125	.7500	3/64	1/64	25578-25520	1.6875	3.2650	.9375	.090	1/32	639-632	2.5000	5.3750	1.6250	9/64	1/8
15100-15250	1.0000	2.5000	.8125	9/64	3/64	3579-3525	1.6875	3.4375	1.1875	9/64	1/8	6379-6320	2.5625	5.3447	2.1250	9/64	1/8
2687-2631	1.0000	2.6150	.9375	3/64	3/64	3423-332	1.6880	3.1496	.8268	9/64	3/64	3953-394A	2.6250	4.3307	.8661	9/64	3/64
26100-26283	1.0000	2.8345	.7480	1/16	1/16	26884-26820	1.6880	3.1562	1.0000	9/64	1/8	3984-3920	2.6250	4.4375	1.1875	9/64	1/8
15580-15520	1.0625	2.2500	.6875	9/64	1/16	25577-25520	1.6880	3.2650	.9375	9/64	1/32	33262-33462	2.6250	4.6250	1.1875	9/64	1/8
1985-1932	1.1250	2.3125	.7500	1/32	3/64	12175-12303	1.7500	3.0312	.6875	.060	.060	479-472A	2.6250	4.7244	1.1418	1/32	1/8
15112-15250	1.1250	2.5000	.8125	9/64	3/64	13175-13318	1.7500	3.1875	.7500	0	1/16	560-552A	2.6250	4.8750	1.5000	9/64	1/8
2689-2631	1.1250	2.6150	.9375	1/64	3/64	35175-35326	1.7500	3.2650	.8750	9/64	1/32	641-632	2.6250	5.3750	1.6250	9/64	1/8
02474-02420	1.1250	2.6875	.6760	1/32	1/16	25580-25520	1.7500	3.2650	.9375	9/64	1/32	399A-394A	2.6875	4.3307	.8661	3/32	3/64
2578-2523	1.1250	2.7500	.9375	3/32	3/64	355-354A	1.7500	3.3464	.8125	3/32	3/64	480-472A	2.6875	4.7244	1.1418	9/64	1/8
26112-26283	1.1250	2.8347	.7480	1/16	1/16	3578-3525	1.7500	3.4375	1.1875	9/64	1/8	5608-552A	2.6875	4.8750	1.5000	9/64	1/8
3198-3120	1.1250	2.8593	1.1875	3/64	1/8	49175-49368	1.7500	3.6875	1.2500	9/64	1/8	570-563	2.6875	5.0000	1.4375	9/64	1/8
02872-02820	1.1250	2.8750	.8750	1/32	1/8	46176-46368	1.7500	3.6875	1.2500	9/64	1/8	33275-33462	2.7500	4.6250	1.1875	9/64	1/8
2690-2631	1.1562	2.6150	.9375	9/64	3/64	438-432	1.7500	3.7500	1.0938	9/64	3/32	482-472A	2.7500	4.7244	1.1418	9/64	1/8
17118-17244	1.1805	2.4410	.6300	1/16	1/16	527-522	1.7500	4.0000	1.3750	9/64	1/8	566-563	2.7500	5.0000	1.4375	9/64	1/8
15117-15250	1.1805	2.5000	.8125	3/64	3/64	460-453X	1.7500	4.1250	1.1875	9/64	1/8	643-632	2.7500	5.3750	1.6250	9/64	1/8
14117A-14276	1.1810	2.7170	.7813	9/64	3/64	59175-59412	1.7500	4.1250	1.4375	9/64	1/8	655-652	2.7500	6.0000	1.6250	9/64	1/8
17119-17244	1.1875	2.4410	.6300	1/16	1/16	535-532X	1.7500	4.2500	1.4375	9/64	1/8	835-832	2.7500	6.6250	1.2500	9/64	1/8
2588-2523	1.1875	2.7500	.9375	3/32	3/64	65385-65321	1.7500	4.5000	1.7500	9/64	1/32	33281-33462	2.8125	4.6250	1.1875	9/64	1/8
3191-3120	1.1875	2.8593	1.1875	9/64	1/8	615-612	1.7500	4.7500	1.6250	9/64	1/8	567A-563	2.8125	5.0000	1.4375	9/64	1/8
15118-15250	1.1895	2.5000	.8125	9/64	3/64	25584-25520	1.7710	3.2650	.9375	1/16	1/32	645-632	2.8125	5.3750	1.6250	1/4	1/8
14119A-14276	1.1900	2.7170	.7813	1/32	3/64	3776-3720	1.7710	3.6718	1.1875	9/64	1/8	587-583	2.8750	5.0000	1.4375	9/64	1/8
1674-1620	1.2450	2.6250	.8125	1/16	1/16	358-354A	1.7716	3.3464	.8125	1/16	3/64	744-742	2.8750	5.9090	1.7500	9/64	1/8
08125-08231	1.2500	2.3125	.5781	.040	.040	376-372A	1.7716	3.8125	.8750	1/32	1/16	657-652	2.8750	6.0000	1.6250	9/64	1/8
02475-02420	1.2500	2.6875	.8750	9/64	1/16	18690-18620	1.8125	3.1250	.6875	7/64	1/16	568-563	2.9062	5.0000	1.4375	1/32	1/8
14125A-14276	1.2500	2.7170	.7813	9/64	3/64	13181-13318	1.8125	3.1875	.7500	1/32	1/16	34300-34478	3.0000	4.7812	.9688	.080	.080
2582-2523	1.2500	2.7500	.9375	9/64	3/64	3593-354A	1.8125	3.3464	.8125	3/32	3/64	47680-47620	3.0000	5.2500	1.3125	1/32	1/8
3193-3120	1.2500	2.8593	1.1875	9/64	1/8	2984-2924	1.8125	3.3464	1.0000	9/64	3/64	495A-493	3.0000	5.3750	1.1875	9/64	1/8
02875-02820	1.2500	2.8750	.8750	9/64	1/8	436-432	1.8125	3.7500	1.0938	9/64	3/32	575-572	3.0000	5.5118	1.4375	9/64	1/8
2875-2820	1.2500	2.8750	.8750	9/64	1/8	369A-362A	1.8750	3.5000	.8125	9/64	3/64	6461-6420	3.0000	5.8750	2.1250	9/64	1/8
3476-3420	1.2500	3.1250	1.1563	3/64	1/8	3778-3720	1.8750	3.6718	1.1875	1/4	1/8	7488-742	3.0000	5.9090	1.7500	9/64	1/8
346-332	1.2500	3.1496	.8268	1/32	3/64	528-522	1.8750	4.0000	1.3750	9/64	1/8	659-652	3.0000	6.0000	1.6250	9/64	1/8
26126-26283	1.2600	2.8345	.7480	1/16	1/16	5358-5335	1.8750	4.0625	1.7188	3/64	1/8	6576-6535	3.0000	6.3750	2.1250	9/64	1/8
14130-14276	1.3125	2.7170	.7813	9/64	3/64	463-453X	1.8750	4.1250	1.1875	3/16	1/8	643-632	3.0000	6.6250	2.1250	1/4	1/8
2585-2523	1.3125	2.7500	.9375	9/64	3/64	536-532X	1.8750	4.2500	1.4375	9/64	1/8	34306-34478	3.0625	4.7812	.9688	9/64	.080
2876-2820	1.3125	2.8750	.8750	9/64	1/8	617-612	1.8750	4.7500	1.6250	9/64	1/8	47681-47620	3.1875	5.2500	1.3125	9/64	1/8
2785-2720	1.3125	3.0000	.9375	9/64	1/8	5395-5335	1.9375	4.0625	1.7188	9/64	1/8	496-493	3.1875	5.3750	1.1875	9/64	1/8
31590-31520	1.3125	3.0000	1.1563	1/32	1/8	366-362A	1.9685	3.5000	.8125	3/32	3/64	581-572	3.1875	5.5118	1.4375	9/64	1/8
14137A-14276	1.3750	2.7170	.7813	1/16	3/64	465-453X	1.9685	4.1250	1.1875	3/32	1/8	740-742	3.1875	5.9090	1.7500	13/64	1/8
02877-02820	1.3750	2.8750	.8750	9/64	1/8	18200-18337	2.0000	3.3750	.7500	.060	.060	838-832	3.1875	6.6250	2.1250	1/32	1/8
2878-2820	1.3750	2.8750	.8750	1/32	1/8	368A-362A	2.0000	3.5000	.8125	9/64	3/64	47686-47620	3.2500	5.2500	1.3125	9/64	1/8
25878-25820	1.3750	2.8750	.9375	9/64	3/32	3780-3720	2.0000	3.6718	1.1875	9/64	1/8	495-493	3.2500	5.3750	1.1875	9/64	1/8
2786-2720	1.3750	3.0000	.9375	13/64	1/8	375-372A	2.0000	3.8125	.8750	1/32	1/16	580-572	3.2500	5.5115	1.4375	9/64	1/8
30137-36300	1.3750	3.0000	1.1563	1/16	1/8	49585-49520	2.0000	4.0000	1.2500	9/64	1/8	663-652	3.2500	6.0000	1.6250	9/64	1/8
31593-31520	1.3780	3.0000	1.1563	9/64	1/8	529X-522	2.0000	4.0000	1.3780	9/64	1/8	842-832	3.2500	6.6250	2.1250	9/64	1/8
3478-3420	1.3750	3.1250	1.1563	9/64	1/8	455-453X	2.0000	4.1250	1.1875	1/32	1/8	498-493	3.3125	5.3750	1.1875	9/64	1/8
335-332	1.3750	3.1496	.8268	1/32	3/64	59200-59412	2.0000	4.1250	1.4375	9/64	1/8	749-742	3.3475	5.9090	1.7500	9/64	1/8
3379-3320	1.3750	3.1562	1.1563	9/64	1/8	4580-4535	2.0000	4.1250	1.5625	9/64	1/8	598-592A	3.3750	6.0000	1.5625	9/64	1/8
417-414	1.3750	3.4843	1.0625	1/32	1/32	537-532X	2.0000	4.2500	1.4375	9/64	1/8	665-652	3.3750	6.0000	1.6250	9/64	1/8
449-432	1.3750	3.7500	1.0938	1/32	1/32	3975-3920	2.0000	4.4375	1.1875	9/64	1/8	593-592A	3.5000	6.0000	1.5625	9/64	1/8
19138-19283	1.3770	2.8345	.6700	1/16	1/16	619-612	2.0000	4.7500	1.6250	9/64	1/8	759-752	3.5000	6.3750	1.6750	9/64	1/8
339-332	1.3779	3.1496	.8268	1/32	3/64	555-552A	2.0000	4.8750	1.5000	3/32	1/8	855-854	3.5000	7.5000	2.2500	5/16	1/8
26883-26820	1.3779	3.1562	1.0000	1/32	1/8	6279-6220	2.0000	5.000	2.0000	9/64	1/8	69354-69630	3.5430	6.3030	1.1860	1/32	1/8
2794-2720	1.4365	3.0000	.9375	9/64	1/8	3767-3720	2.0625	3.6718	1.1875	1/32	1/8	598-592A	3.6250	6.0000	1.5625	9/64	1/8
19143-19283	1.4375	2.8345	.6700	1/16	1/16	33890-33821	2.0625	3.7500	1.0938	1/16	3/32	77362-77675	3.6250	6.7500	1.8750	9/64	1/8
16143-16284	1.4375	2.8440	.8125	9/64	3/64	377-372A	2.0625	3.8125	.8750	1/32	1/16	42368-42584	3.6875	5.8437	1.1250	.120	.120
3878-3820	1.4375	3.3750	1.1875	1/32	1/8	540-532X	2.0625	4.2500	1.4375	9/64	1/8	42376-42584	3.7500	5.8437	1.1250	.120	.120
13889-13836	1.5000	2.5625	.5000	1/16	1/32	389A-382	2.1250	3.8750	.8268	1/32	1/32	594-592A	3.7500	6.0000	1.5625	9/64	1/8
13685-13621	1.5000	2.7170	.7500	9/64	3/32	456-453X	2.1250	4.1250	1.1875	9/64	1/8	683-672	3.7500	6.6250	1.6250	9/64	1/8
19150-19283	1.5000	2.8345	.6700	.060	1/16	4595-4535	2.1250	4.1250	1.5625	9/64	1/8	77375-77675	3.7500	6.7500	1.8750	9/64	1/8
16150-16284	1.5000	2.8440	.8125	9/64	3/64	539-532X	2.1250	4.2500	1.4375	9/64	1/8	685-672	3.8750	6.6250	1.6250	9/64	1/8
2788-2720	1.5000	3.0000	.9375	9/64	1/8	621-612	2.1250	4.7500	1.6250	9/64	1/8	779-772	3.8750	7.1250	1.8750	9/64	1/8
3490-3420	1.8000	3.1250	1.1563	9/64	1/8	3873-352A	2.1250	4.8750	1.5000	9/64	1/8	52400-52618	4.0000	6.1875	1.4375	9/64	1/8



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SHEET NUMBER . . . D-26 (con'td)
CLASSIFICATION . . Materials
SUB CLASSIFICATION . Ball & Roller Bearings

Closer Tolerance Specifications 3 and 5

Sizes given are those used on aircraft; for larger sizes write AFBMA.

BALL BEARING CODE NUMBERS		SPECIFICATION 3				
Type BC	Type BH	BORE	OUTER DIAM.	INDIV. RING WIDTH	ECCENTRICITY	
		+.0000	+.0000	+.000	Inner	Outer
DIMENSION SERIES 02 (Light)						
4BC03-3		-.0002	-.0003	-.005	.0002	.0004
5BC03-3		-.0002	-.0003	-.005	.0002	.0004
6BC02-3		-.0002	-.0003	-.005	.0002	.0004
7BC02-3		-.0002	-.0003	-.005	.0002	.0004
8BC10-3		-.0002	-.0003	-.005	.0002	.0004
9BC02-3		-.0002	-.0003	-.005	.0002	.0004
10BC02-3	10BH02-3	-.0002	-.0003	-.005	.0003	.0004
12BC02-3	12BH02-3	-.0002	-.0003	-.005	.0003	.0004
15BC02-3	15BH02-3	-.0002	-.0003	-.005	.0003	.0004
17BC02-3	17BH02-3	-.0002	-.0003	-.005	.0003	.0004
20BC02-3	20BH02-3	-.0002	-.0003	-.005	.0003	.0004
25BC02-3	25BH02-3	-.0002	-.0004	-.005	.0003	.0005
30BC02-3	30BH02-3	-.0002	-.0004	-.005	.0003	.0005
35BC02-3	35BH02-3	-.0003	-.0004	-.005	.0004	.0005
40BC02-3	40BH02-3	-.0003	-.0004	-.005	.0004	.0005
45BC02-3	45BH02-3	-.0003	-.0004	-.005	.0004	.0007
50BC02-3	50BH02-3	-.0003	-.0004	-.005	.0004	.0007
55BC02-3	55BH02-3	-.0004	-.0004	-.005	.0004	.0007
60BC02-3	60BH02-3	-.0004	-.0004	-.005	.0004	.0007
65BC02-3	65BH02-3	-.0004	-.0004	-.005	.0004	.0007
70BC02-3	70BH02-3	-.0004	-.0005	-.005	.0004	.0008
75BC02-3	75BH02-3	-.0004	-.0005	-.005	.0004	.0008
80BC02-3	80BH02-3	-.0004	-.0005	-.005	.0004	.0008
85BC02-3	85BH02-3	-.0005	-.0005	-.005	.0005	.0008
90BC02-3	90BH02-3	-.0005	-.0006	-.005	.0005	.0009
95BC02-3	95BH02-3	-.0005	-.0006	-.005	.0005	.0009
100BC02-3	100BH02-3	-.0005	-.0006	-.005	.0005	.0009
DIMENSION SERIES 03 (Medium)						
10BC03-3	10BH03-3	-.0002	-.0003	-.005	.0003	.0004
12BC03-3	12BH03-3	-.0002	-.0003	-.005	.0003	.0004
15BC03-3	15BH03-3	-.0002	-.0003	-.005	.0003	.0004
17BC03-3	17BH03-3	-.0002	-.0003	-.005	.0003	.0004
20BC03-3	20BH03-3	-.0002	-.0004	-.005	.0003	.0005
25BC03-3	25BH03-3	-.0002	-.0004	-.005	.0003	.0005
30BC03-3	30BH03-3	-.0002	-.0004	-.005	.0003	.0005
35BC03-3	35BH03-3	-.0003	-.0004	-.005	.0004	.0005
40BC03-3	40BH03-3	-.0003	-.0004	-.005	.0004	.0007
45BC03-3	45BH03-3	-.0003	-.0004	-.005	.0004	.0007
50BC03-3	50BH03-3	-.0003	-.0004	-.005	.0004	.0007
55BC03-3	55BH03-3	-.0004	-.0004	-.005	.0004	.0007
60BC03-3	60BH03-3	-.0004	-.0005	-.005	.0004	.0008
65BC03-3	65BH03-3	-.0004	-.0005	-.005	.0004	.0008
70BC03-3	70BH03-3	-.0004	-.0005	-.005	.0004	.0008
75BC03-3	75BH03-3	-.0004	-.0006	-.005	.0004	.0009
80BC03-3	80BH03-3	-.0004	-.0006	-.005	.0004	.0009
85BC03-3	85BH03-3	-.0005	-.0006	-.005	.0005	.0009
90BC03-3	90BH03-3	-.0005	-.0007	-.005	.0005	.0010
95BC03-3	95BH03-3	-.0005	-.0007	-.005	.0005	.0010
100BC03-3	100BH03-3	-.0005	-.0007	-.005	.0005	.0010
DIMENSION SERIES 04 (Heavy)						
17BC04-3	17BH04-3	-.0002	-.0004	-.005	.0003	.0005
20BC04-3	20BH04-3	-.0002	-.0004	-.005	.0003	.0005
25BC04-3	25BH04-3	-.0002	-.0004	-.005	.0003	.0005
30BC04-3	30BH04-3	-.0002	-.0004	-.005	.0003	.0007
35BC04-3	35BH04-3	-.0003	-.0004	-.005	.0004	.0007
40BC04-3	40BH04-3	-.0003	-.0004	-.005	.0004	.0007
45BC04-3	45BH04-3	-.0003	-.0004	-.005	.0004	.0007
50BC04-3	50BH04-3	-.0003	-.0005	-.005	.0004	.0008
55BC04-3	55BH04-3	-.0004	-.0005	-.005	.0004	.0008
60BC04-3	60BH04-3	-.0004	-.0005	-.005	.0004	.0008
65BC04-3	65BH04-3	-.0004	-.0006	-.005	.0004	.0009
70BC04-3	70BH04-3	-.0004	-.0006	-.005	.0004	.0009
75BC04-3	75BH04-3	-.0004	-.0007	-.005	.0004	.0010
80BC04-3	80BH04-3	-.0004	-.0007	-.005	.0004	.0010
85BC04-3	85BH04-3	-.0005	-.0007	-.005	.0005	.0010
90BC04-3	90BH04-3	-.0005	-.0007	-.005	.0005	.0010

BALL BEARING CODE NUMBERS		SPECIFICATION 5				
Type BC	Type BH	BORE	OUTER DIAM.	INDIV. RING WIDTH	ECCENTRICITY	
		+.0000	+.0000	+.000	Inner	Outer
DIMENSION SERIES 02 (Light)						
4BC03-5		-.0002	-.0002	-.005	.0002	.0002
5BC03-5		-.0002	-.0002	-.005	.0002	.0002
6BC02-5		-.0002	-.0002	-.005	.0002	.0002
7BC02-5		-.0002	-.0002	-.005	.0002	.0002
8BC10-5		-.0002	-.0002	-.005	.0002	.0002
9BC02-5		-.0002	-.0002	-.005	.0002	.0002
10BC02-5	10BH02-5	-.0002	-.0002	-.005	.0002	.0002
12BC02-5	12BH02-5	-.0002	-.0002	-.005	.0002	.0002
15BC02-5	15BH02-5	-.0002	-.0002	-.005	.0002	.0002
17BC02-5	17BH02-5	-.0002	-.0002	-.005	.0002	.0002
20BC02-5	20BH02-5	-.0002	-.0002	-.005	.0002	.0002
25BC02-5	25BH02-5	-.0002	-.0003	-.005	.0002	.0003
30BC02-5	30BH02-5	-.0002	-.0003	-.005	.0002	.0003
35BC02-5	35BH02-5	-.0002	-.0003	-.005	.0002	.0003
40BC02-5	40BH02-5	-.0002	-.0003	-.005	.0002	.0003
45BC02-5	45BH02-5	-.0002	-.0003	-.005	.0002	.0004
50BC02-5	50BH02-5	-.0002	-.0003	-.005	.0002	.0004
55BC02-5	55BH02-5	-.0003	-.0003	-.005	.0002	.0004
60BC02-5	60BH02-5	-.0003	-.0003	-.005	.0002	.0004
65BC02-5	65BH02-5	-.0003	-.0003	-.005	.0002	.0004
70BC02-5	70BH02-5	-.0003	-.0004	-.005	.0002	.0004
75BC02-5	75BH02-5	-.0003	-.0004	-.005	.0002	.0004
80BC02-5	80BH02-5	-.0003	-.0004	-.005	.0002	.0004
85BC02-5	85BH02-5	-.0003	-.0004	-.005	.0003	.0004
90BC02-5	90BH02-5	-.0003	-.0005	-.005	.0003	.0005
95BC02-5	95BH02-5	-.0003	-.0005	-.005	.0003	.0005
100BC02-5	100BH02-5	-.0003	-.0005	-.005	.0003	.0005
DIMENSION SERIES 03 (Medium)						
10BC03-5	10BH03-5	-.0002	-.0002	-.005	.0002	.0002
12BC03-5	12BH03-5	-.0002	-.0002	-.005	.0002	.0002
15BC03-5	15BH03-5	-.0002	-.0002	-.005	.0002	.0002
17BC03-5	17BH03-5	-.0002	-.0002	-.005	.0002	.0002
20BC03-5	20BH03-5	-.0002	-.0003	-.005	.0002	.0003
25BC03-5	25BH03-5	-.0002	-.0003	-.005	.0002	.0003
30BC03-5	30BH03-5	-.0002	-.0003	-.005	.0002	.0003
35BC03-5	35BH03-5	-.0002	-.0003	-.005	.0002	.0003
40BC03-5	40BH03-5	-.0002	-.0003	-.005	.0002	.0004
45BC03-5	45BH03-5	-.0002	-.0003	-.005	.0002	.0004
50BC03-5	50BH03-5	-.0002	-.0003	-.005	.0002	.0004
55BC03-5	55BH03-5	-.0003	-.0003	-.005	.0002	.0004
60BC03-5	60BH03-5	-.0003	-.0004	-.005	.0002	.0004
65BC03-5	65BH03-5	-.0003	-.0004	-.005	.0002	.0004
70BC03-5	70BH03-5	-.0003	-.0004	-.005	.0002	.0004
75BC03-5	75BH03-5	-.0003	-.0005	-.005	.0002	.0005
80BC03-5	80BH03-5	-.0003	-.0005	-.005	.0002	.0005
85BC03-5	85BH03-5	-.0003	-.0005	-.005	.0003	.0005
90BC03-5	90BH03-5	-.0003	-.0005	-.005	.0003	.0005
95BC03-5	95BH03-5	-.0003	-.0005	-.005	.0003	.0005
100BC03-5	100BH03-5	-.0003	-.0005	-.005	.0003	.0005
DIMENSION SERIES 04 (Heavy)						
17BC04-5	17BH04-5	-.0002	-.0003	-.005	.0002	.0003
20BC04-5	20BH04-5	-.0002	-.0003	-.005	.0002	.0003
25BC04-5	25BH04-5	-.0002	-.0003	-.005	.0002	.0003
30BC04-5	30BH04-5	-.0002	-.0003	-.005	.0002	.0004
35BC04-5	35BH04-5	-.0002	-.0003	-.005	.0002	.0004
40BC04-5	40BH04-5	-.0002	-.0003	-.005	.0002	.0004
45BC04-5	45BH04-5	-.0002	-.0003	-.005	.0002	.0004
50BC04-5	50BH04-5	-.0002	-.0004	-.005	.0002	.0004
55BC04-5	55BH04-5	-.0003	-.0004	-.005	.0002	.0004
60BC04-5	60BH04-5	-.0003	-.0004	-.005	.0002	.0004
65BC04-5	65BH04-5	-.0003	-.0005	-.005	.0002	.0005
70BC04-5	70BH04-5	-.0003	-.0005	-.005	.0002	.0005
75BC04-5	75BH04-5	-.0003	-.0005	-.005	.0002	.0005
80BC04-5	80BH04-5	-.0003	-.0005	-.005	.0002	.0005
85BC04-5	85BH04-5	-.0003	-.0005	-.005	.0003	.0005
90BC04-5	90BH04-5	-.0003	-.0005	-.005	.0003	.0005

(Courtesy of Anti-Friction Bearing Manufacturers Assn.)

REVIEW OF PATENTS

By A. HARRY CROWELL *Registered Patent Lawyer*

FOLLOWING are digests of some of the more interesting recent patents on aviation developments granted by the U. S. Patent Office. Mr. Crowell will gladly furnish readers with free information on approximate cost and procedure in applying for patents and trademark registration. Address inquiries to him, care AVIATION, 330 W. 42nd St., New York City (18). Printed copies of any of patents listed are obtainable at a cost of 10c. each, directly from U. S. Patent Office, Washington.

Internal Control Surface installed in stabilizer, fin, wing, or fuselage, is designed to permit restoring force to be varied in magnitude to offset undesirable restoring forces produced by movement of airplane center of gravity, thereby improving range of C.G. travel. Device has faces sealed from each other and fitted with air ducts so that angular disturbance of craft will cause different pressures on faces, resulting force being transmitted to produce movement about hinge axis of main exterior control surface or to effect motion of tab.—2,368,059, filed Dec. 8, '41, pat. Jan. 23, '45, R. J. White.

Joint or Truss Construction for aircraft aims to provide high strength and light weight features and permit simple, inexpensive fabrication methods. Wing-embodiment of invention includes skin-supporting channel member fitted with slotted holding member and web member having channel at one end slotted to receive skin-supporting member.—2,367,750, filed Jan. 17, '41, pat. Jan. 23, '45, M. Berkow and C. F. Mullen, assignors to Central Aircraft Corp.

Landing Platform intended to facilitate operation of helicopters to and from small vessels of limited free deck area provides means for driving platform along arcuate track in direction opposite to direction of roll and at a controlled speed commensurate with rolling speed so as to maintain flight surface horizontal, crosswise of vessel as it rolls.—2,368,159, filed July 20, '43, pat. Jan. 30, '45, S. D. Robins.

Engine Mounting Bracket of simplified split-spool rubber-insulated type has each half equipped with metal sleeve formed to embrace mounting ring, a shear pin being fitted through and held in place in sleeve and outer shell of mounting bracket. Split halves are given self-adjusting movement about single offset mounting bolt attaching bracket to engine, while resiliency of bond between sleeves and bracket shell allows appreciable relative twisting and axial and lateral movements between the two.—2,368,533, filed Apr. 14, '43, pat. Jan. 30, '45, W. S. Fletcher, assignor to Fletcher Aviation Corp.

Airplane Mail Loading and unloading device is designed to facilitate delivery of mail bag to and from moving plane by means of elevated runway provided with crane carriage mounted on trackways and moving longitudinally of runway. Carriage is set in motion by catapult device at each end of runway frame.—2,369,133, filed Nov. 27, '41, pat. Feb. 13, '45, G. Burton.

Aircraft Construction, permitting materially reduced cross-section, contemplates accommodations for placing pilot in prone position with full support for body and head to better withstand high acceleration forces encountered in pullouts. Invention also provides control system adapted to prone position.—2,369,258, filed Apr. 3, '41, pat. Feb. 13, '45, H. V. Shebat.

(*Turn to page* 305)

Book Reviews

PRECISION MEASUREMENT IN THE METAL WORKING INDUSTRY. Two Volumes. Syracuse University Press, N. Y. 553 pages, photos, graphs, problems.

Employing a format and typography specially designed for easy grasp of its information, this present edition, prepared by the Department of Education of International Business Machines Corp., lays emphasis upon the development of measuring methods giving precision to the evolution of metal machines and their production. Extreme detailed and profusely illustrated, the subject is treated in minute detail, with instrument after instrument dissected and their uses explained.

CARRIER WAR, by Lt. Oliver Jensen, USNR. Pocket Books, Inc., N. Y. C. 173 pages, text, photos. $.50.

Story of American carrier craft and their exploits in the Pacific war, told in a clear and comprehensive exposition of the succession of events from Hollandia to the battles of the Philippine Sea. Color photos, black and whites, and a competent text give this paper-bound volume attractive and informative qualities.

PHOTOGRAPHIC SURVEYING, by Col. B. B. Talley and Paul H. Robbins. Pitman Publishing Corp., N. Y. C.-Chicago. 223 pages, text, photos, index. $3.00.

Concise compilation of data on photographic surveying from the air. Discussion and photographs of equipment is followed by sections on interpretation, image displacements, control and extension, detail compilation, stereoscopy, stereoscopic plotting instruments, aerial photographic mosaics, and application of photographic surveying.

AIRFRAME MATERIALS, by F. S. Stewart. McGraw-Hill Book Co., N. Y. C. 237 pages, text, photos, graphs, index. $2.50.

Discussion of the mechanics of airframe materials with an account of the processes used to assemble the various lightweight

(*Turn to page* 252)

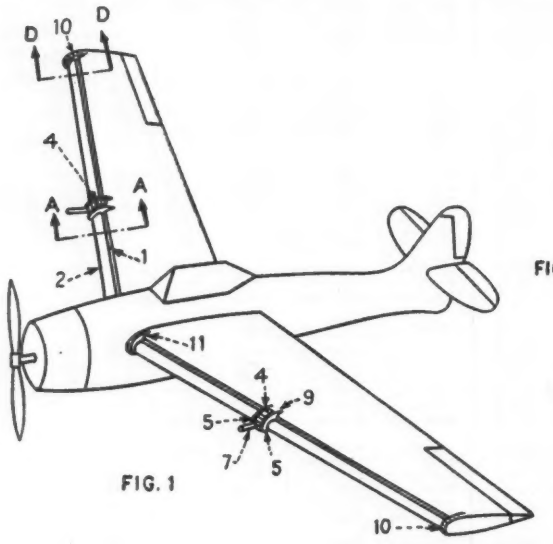


FIG. 1

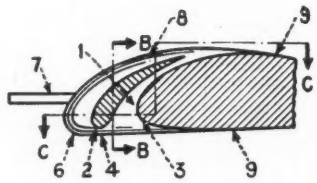


FIG. 2. Sectional view on line A-A, Fig. 1.

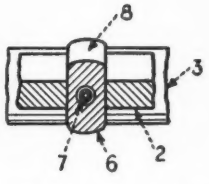


FIG. 3. Sectional view on line B-B, Fig. 2.

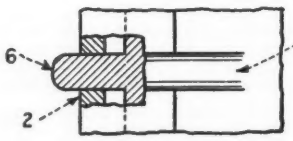


FIG. 4. Sectional view on line C-C, Fig. 2.

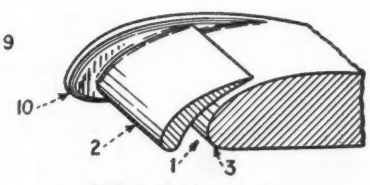


FIG. 5. Sectional view on line D-D, Fig. 1.

Wing Slot Baffle is designed to eliminate disturbance in slot-airflow caused by obstructions such as pitot tubes or guns extending ahead of leading edge and across slot. In accompanying Figs. 1 to 5, conventional wing slot (1) is between slat (2) and leading edge (3). Wing slot baffle (4) has plates (5) on opposite sides of baffle tip (6) which is shaped substantially the same as leading edge (3) but is slightly enlarged and projects from leading edge across slot (1) and forward of slat (2). Baffle tip, of sufficient width to completely enclose the obstruction—shown as machine gun (7)—is streamlined as at (8), and fairs smoothly into wing as at (9). Hence, airflow entering slot (1) is not disturbed by presence of gun barrel and is directed smoothly through slot. Disturbance of airflow at either end of slot is eliminated by baffle (10) at wing tip and baffle (11) at wing roll between fuselage and wing. These baffles also serve as end brackets for slot, and baffle (4) acts as center support.—2,368,205, filed June 29, '42, pat. Jan. 30, '45, W. S. Diehl.

TWA Constellation by Lockheed

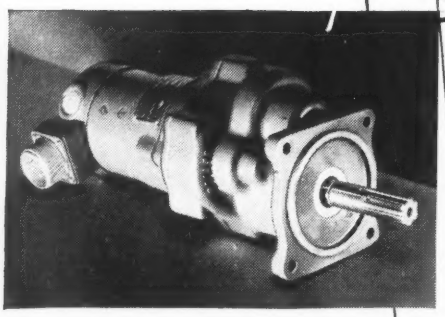
DESIGNED FOR PEACE, DRAFTED FOR WAR. That's the story of the Constellation. Originally planned for TWA . . . for new luxurious, five-mile-a-minute cross-continent service . . . these super air liners joined the Army Air Force instead . . . carrying not 57 passengers in deep-cushioned chairs but providing sterner accommodations for 100 fully armed soldiers.

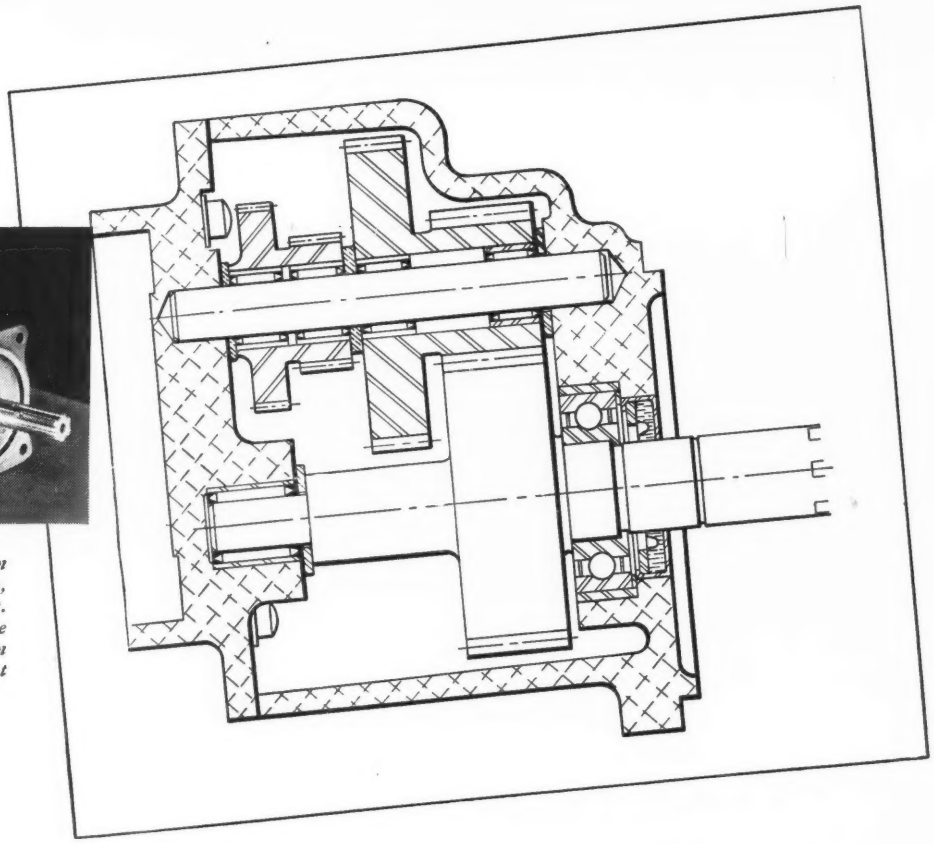
But when the war is over, the Constellation will return to the job awaiting it . . . that of carrying mail, passengers and express over the TWA system.

And when the war is over, many of the remarkable developments contributing to military aviation again will be ready to serve in other fields. PESCO design and manufacturing experience in meeting the exacting demands of military aviation will be available not only to commercial aviation, but also to industry in expanded and more effective industrial applications of Pressurized Power and Liquid Flow. For descriptive literature, write PESCO Products Co., division of Borg-Warner, 11610 Euclid Avenue, Cleveland 6, Ohio.

In Precision Hydraulics, Fuel Pumps, Air Pumps, Related Accessories . . .

PERFORMANCE POINTS TO Pesco FIRST





X-section shows 5 of the 7 anti-friction Needle Bearings used on Air Associates, Inc. gear reduction drive for aircraft. This is typical of Torrington Needle Bearing use to get the high anti-friction performance from small design weight and space.

Needle Bearings Give Increased Design and Operating Efficiency to Gear Reduction Drives

Torrington Needle Bearings combine unusually high load capacity into a small, compact bearing with low coefficient of friction that offers many design advantages. That's why, in the widely used gear reduction drive made by Air Associates, Inc. for the retractable landing gears, canopies and other moving parts of so many fighter aircraft, the gears and shafts turn on these modern anti-friction needle bearings.

Torrington Needle Bearings are light in weight and compact, yet engineered to stand up to high speeds and heavy loads. They also permit other weight and space savings in the design of housings and other component parts . . . are easy to install, maintain and lubricate!

Why not have these Torrington Needle Bearing advantages on the tools or machinery you design, build or operate? Our Catalog No. 32-A is packed with useful data on anti-friction Needle Bearing applications ranging from kitchen appliances to textile and agricultural machinery. You should have this helpful data in your engineering and design files. Drop us a line and we'll gladly send you a copy.

•

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TORRINGTON NEEDLE BEARINGS

SIDE SLIPS

READING OUR RECENT dissertation on the gastronomic effects of fast-flying planes—you know, take off here and have lunch there—prompted a friend to call and say that manufacturers may soon design themselves right out of this wonderful publicity hook. "First thing you know," this man-who-loves-free-meals says, "a passenger will have to buy his own lunch in New York and will get to Chicago in time for lunch there . . . or take off after breakfast in New York and have to pay for his own lunch in Los Angeles."

We don't think speeds will get quite *that* high, though; too many wolves would kick about not having enough time to haunt the stewardesses.

• Speaking of food, an item from one of the bomber bases came up with this: "The plane these boys fly is the Consolidated Liberator, which is 66 ft. in length, 18 ft. in height, and has 110 ft. of spam." To which the little man looking over our shoulder says glumly, "Ye gods, imagine 110 ft. of that stuff anywhere, let alone in one airplane."

• That "great shipbuilder" now reaps himself a few headlines by announcing plans for a grandiose airport in San Francisco. That'll be just the place to base those 5,000 flying boats he was going to build back in 1942—but never did. Or those three big flying boats, which were to have been delivered as per an $18,000,000 contract in December of 1943, May and Oct. of last year—but which have yet to be turned over to the government. Or all the scheduled Navy fighters which didn't get delivered before the contracts were cancelled. Or is it for those $490 helicopters he long ago forecast?

• News item in New York paper: "At the end of a flight from an overseas base with 23 passengers and a crew of six children, an Air Transport Command C-54 plane was damaged slightly by fire today at La Guardia Field. The fire was confined to one engine."

Maybe ATC should put a seventh child in the crew—let him be fire chief.

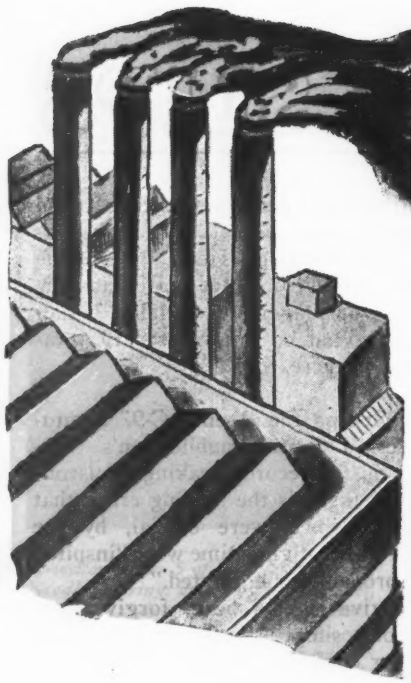
• You may have heard of that P-38 pilot being forced down behind Nazi lines and being followed right along by his buddy, who landed nearby for the rescue. The rescuee just jumped in and sat on the rescuer's lap—since it definitely wasn't a piggy back job. Then back into the air they went and returned safely to base, going even so far as to taxi the ship into its proper place under direction of the crew chief, who had been sweating out his pilot's failure to get back on time. Anyhow, the shock of seeing a strange grinning mug step out of the plane wasn't ameliorated one bit when his pilot also came up and out. They say the poor chief has now so steeled himself that a horse—complete, that is—could come out and he'd never turn a hair.

• Over in Italy not long ago 19 men had to get some place in a hurry, so they all piled aboard a B-25. As one who was aboard tells it, "don't ask me where we all were, my face was jammed up against a bulkhead so tight I didn't even know how many were in the thing." As they piled out at destination, the operations officer's blood pressure went higher and higher as the count went up. He really beat the pilot's ears down. But not because he had 18 passengers—that didn't bother a bit. What he wanted was 19 parachutes in there, too.

• Discussing the Boeing C-97 Stratocruiser, a British publication's comment on the record-breaking transcontinental flight is the sniping crack that reports—which were official, by the way—of the flight's time were "inspired and probably exaggerated."

Forgive us old bean, forgive us—someone simply forgot to tell those Boeing engineers they're not supposed to build airplanes that in any way exceed those coming out of the tight little isle.

"Maguire kept hollering for carrier duty."



DON'T LET PRE-WAR METHODS KILL POST-WAR PROSPERITY!

The war years have proven to American Industry that the light machine tool has an important place in Production. Walker-Turner machine tools have demonstrated their ruggedness under most exacting conditions.

Don't let pre-war operating methods affect your post-war competitive position. The versatility of Walker-Turner machine tools will ensure production equal to—and, in many cases, better than—heavier and more expensive equipment.

WALKER-TURNER COMPANY, Inc.
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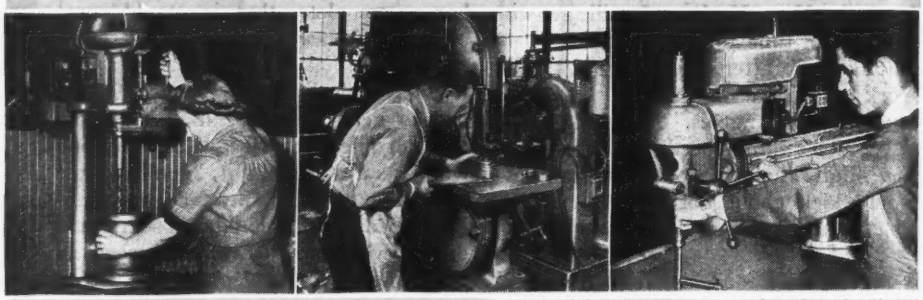
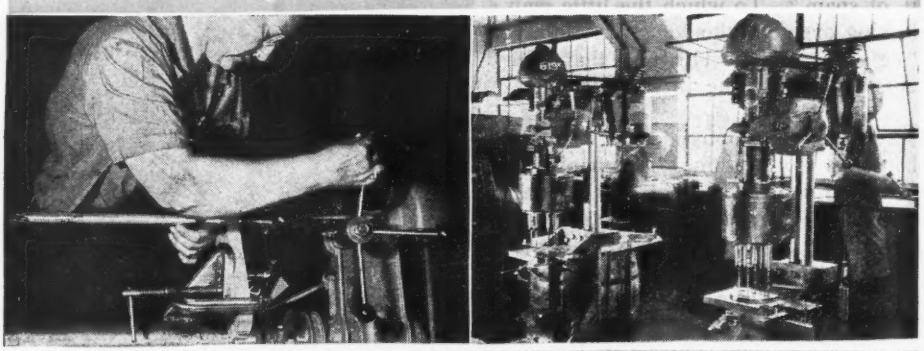
HERE'S HOW WALKER-TURNER MACHINE-TOOLS CUT COSTS!



260-5200 R.P.M. 60-5300 S.F.M. 160-8300 R.P.M.

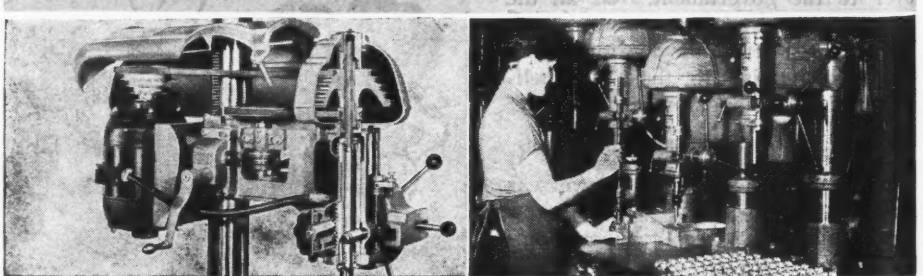
Wide range of operating speeds enables you to select the optimum cutting speed for any material.



Walker-Turner flexibility saves time and cuts costs in special tooling set-ups.

Set up horizontally, this Walker-Turner 15" Drill Press flares the ends of tubing.

This Walker-Turner 20" Drill Press drills five holes and reams two holes in one operation.



Low power consumption reduces operating costs.

This motor on a Walker-Turner 20" Drill Press provides speeds for drilling up to ¾" in steel, 1" in cast iron.

Low price decreases capital investment.

This Walker-Turner 4-spindle 20" Drill Press costs no more than a single heavy unit, yet has several times its production capacity.

walker-turner COMPANY, INC. PLAINFIELD, N.J. U.S.A.

MACHINE TOOLS

DRILL PRESSES — HAND AND POWER FEED • RADIAL DRILLS
METAL-CUTTING BAND SAWS • POLISHING LATHES • FLEXIBLE SHAFT MACHINES
RADIAL CUT-OFF MACHINES FOR METAL • MOTORS • BELT & DISC SURFACERS

THE AVIATION NEWS

BLAINE STUBBLEFIELD, Washington HERB POWELL, New York

Favor Postponement of N-S Certification Question; Ask Simpler Training Procedures

. . . Make progress on airport program; conflicts seen . . . Start radar program for civil field . . . New surplus-PT pricing.

Recently meeting to consider the long-standing question whether non-scheduled aviation should be certificated by CAB and subjected to economic control, CAA's advisory committee on that subject has recommended that no action be taken till at least two years after the war.

The 12-man Non-Scheduled Flying Advisory Committee, appointed by T. P. Wright, CAA Administrator to assist in planning a sound opportunity for maximum air development, reported its opinion that regulation "could be stifling to the development of these services . . .If this branch of aviation is to be hindered, opportunities for thousands of our returning war veterans will be wiped out."

The committee recommended that the general exemption order, Section 292.1 of the Economic Regulations, remain in effect for two years after termination of the war with Japan. This will permit experience to accumulate, give veterans an opportunity to participate, and work to the public interest, the committee said.

Most of the fixed base operators attending CAB examiner's hearings opposed regulation of non-scheduled aviation. They pointed out that this type of flying has been curtailed by the war and suggested the Board wait till activity resumes and then look at the picture.

National Aviation Trades Assn. urged that all aircraft services except charter and contract be permanently exempted from regulation, and it advocated laissez fair as the policy most favorable to maximum development. Roscoe Turner, NATA president, objected strongly to economic regulation.

Airline operators surprised the hearing by agreeing that regulation of non-scheduled services be imposed only after thorough study. It had been presumed that the airlines, fearing competition, would quickly demand certification of the non-scheduled carriers. American and United suggested that regulation be graded upward as small operations grow in scope, with maximum control on regular-schedule certificated lines.

American Airlines contended that certificated carriers have the right, under law, to perform contract services, AA said it intended to offer them. United urged that contract carriers be regulated to prevent "demoralization" of common carriers. CAB attorneys say the Board has the power to regulate non-scheduled common carriers but not contract carriers. Congress has been asked to grant CAB the latter authority.

Informed persons said they expected the Board to postpone economic regulation of non-scheduled carriers, in accordance with testimony.

Ask Simpler Training Procedures

Important recommendations looking toward simplification of training procedures for rapid expansion of personal aviation were made by this same Non-Scheduled Flying Advisory Committee.

Best news for private flyers was the Committee's suggestion that medical examination of applicants for private license be given by any registered physician, in accordance with a simple guide provided by CAA. Administrator Wright announced that the recommendation had been adopted and would take effect June I.

Considering CAB's draft of CAR parts above named, the Committee recommended that the examination for private license be limited solely to contact flight rules and air traffic and pilot rules, as stipulated in Parts 60 and 43 of the proposed regulations.

Additional recommendations: That CAA's system of air marking, in charge of Blanche Noyes, be extended expeditiously to all portions of the country. . .That the Federal Communications Commission simplify radio licensing requirements so that anyone can easily secure a transmitting license. . . .That private pilots without instructor certificates be permitted to give lessons free, culminating in licensing of the student. . . That applicants have at least 8 hr. dual before solo; 4 hr. dual check time after solo; and 28 hr. of solo. In non-spin aircraft: 5 hr. dual before solo; 3 hr. dual check after solo; and 19 hr. solo. . .That aerobatics be flown only when occupants carry approved parachutes and have given their consent. . .That the 0= 100 h. p. range be eliminated and that aircraft 50 percent above or below that of the plane in which pilot has experience, be substituted.

Many other details are contained in CAA's non-scheduled flying committee report.

CAA GETS ADVICE ON N-S PROBLEMS

First meeting of CAA's Non-Scheduled Flying Advisory Committee, group set up to represent personal flyers, manufacturers, airlines, consumers, fixed base operators, and state aviation organizations. Seated (left to right) are William A. M. Burden, Assistant Sec'y of Commerce; Henry A. Wallace, Secretary; and T. P. Wright, CAA Administrator. Standing (left to right) are Ed Williamson, Seattle; Fred Weick, Riverdale, Md.; Douglas Robinson, Los Angeles; William A. Mara, Detroit; Beverly Howard, Orangeburg, S. C.; Arthur I. Boreman, Des Moines; W. T. Piper, Lock Haven, Pa.; Harry Playford, St. Petersburg, Fla.; John Groves, Washington, D. C.; and James C. Johnson, St. Louis. Also committee members, but not in photo, are Edward Garbacz of Little Rock, Ark., and Joseph Bergen of Salt Lake City.

Coming Up

(Meetings and dates subject to wartime conditions under ODT regulations)

June 2: Interhemisphere conference on frequency allocations and revisions, Rio de Janeiro.

June 7-9: Aviation Writers Assn. Annual Conference, Chicago.

Aug. 16-17: IAS Los Angeles Meeting.

Oct. 2-6: IAS Washington, D. C., Meeting.

Oct. 31-Nov. 3: 1945 National Aviation Clinic, Oklahoma City. (Pre-clinic conferences start Oct. 27.)

Note: Pan-American Aircraft Exposition was cancelled for '45 . . .SAE local meetings (being arranged following cancellation of national gathering) will be held in New York, Detroit, Buffalo, Dayton, and Kansas City on dates to be announced . . .Additional IAS meetings are being re-scheduled and will be announced when dates are fixed.

Make Progress on Airport Program; Conflicts Seen

Congressional action on the postwar airport program made headway in March and April: A subcommittee of the Senate Commerce Committee held hearings on a bill by Sen. Josiah Bailey, which is based on CAA's airport master plan proposed to Congress, and on a bill by Sen. Pat McCarran, calling for authorizations of $80,000,000 and $100,000,000, respectively, to be spent in five years after the war.

Other bills in the House, including those of Rep. Clarance Lea and Rep. Jennings Randolph, carrying substantially the same proposals, were scheduled for early hearings.

The matter of providing federal funds to be matched with local money for construction of about 3,000 new airfields, mostly for non-scheduled aviation, is simple compared with the other problems that will enter the controversy. Chief among the latter

FOR SOLONS TO SPROUT WINGS

Rep. Jennings Randolph of W. Va., (left) accepts two-place Aeronca from Aeronca Pres. John W. Friedlander (right), who presented craft to Congressional Flying Club, group of lawmakers banded together to learn flying and to keep hands in. Acceptance ceremony was at Congressional Airport, Washington, D. C.

will be contest between cities, states, and the federal government for jurisdiction and taxing rights. Many aviation leaders want complete federal control so that flying will not be hampered by conflicting and duplicating regulations. But local governments will fight for a share of control, and a compromise seems probable.

Henry Wallace, new Secretary of Commerce, joined in the prevalent opinion that adequate landing facilities is the No. 1 requirement for rapid growth of private aviation. He opposed heavy taxation on aviation gasoline, which was advocated by some Congressmen as a means of footing the airport construction bill.

Start Radar Program For Civil Field

Ten carloads of radar appliances lent to CAA for experimentation at its Indianapolis laboratory initiates the first application of radio detection and ranging for postwar civil aviation. Two main objectives are perfection of a radar screen that will enable the control tower to visualize all aircraft within 25 mi., and a collision warning device, to be installed in airplanes.

The tower could monitor the positions of all nearby planes, and could take over in case of any failure of the new instrument approach system, which will soon be in use. Outbound traffic could be controlled with reference to inbound traffic. Collision warning devices would enable relative separation of any plane from any other plane, or obstruction. Adaptation of this device will be a radar altimeter, showing accurate altitude above ground.

New Surplus-PT Pricing

About 3,000 Army surplus primary trainers — Boeings, Ryans, Fairchilds, and others —are now on sale at fixed prices marked on tags, at 53 RFC sales centers throughout the country. Previous sales were on competitive bids.

★ SPOT CHECKING ★

Rescue by Bell helicopter of two fisherman from thawing ice on Lake Erie near Buffalo marked another mercy-mission milestone for rotary wing aircraft.

Air marking signs which are porcelain-enameled on steel and built in segmented sections for ready assembly have been designed by Market Development Div. of Carnegie-Illinois Steel Corp. Permanency of installation is prime point.

Recent three-day AAF-CAP training conference at Dallas drew more than 170 officers to consideration of CAP's new three-phase training program, expected to set precedent as Patrol progresses in its program of pre-flight work for 250,000 high schoolers.

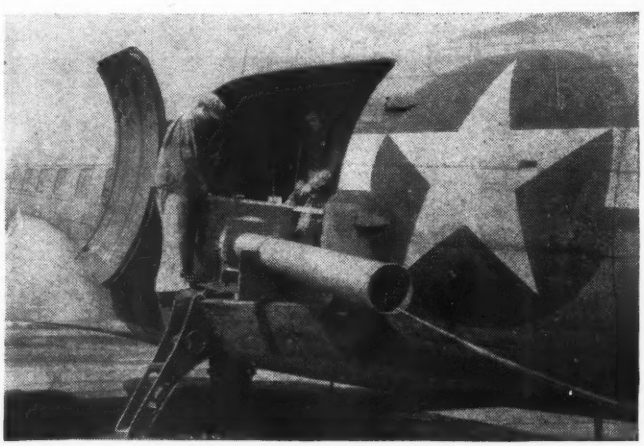
Pilots of World War I who won their wings prior to Nov. 11, 1918, are asked to contact Col. Charles H. Dowman, Hondo Army Air Field, Hondo, Tex., in reference to membership in Order of Daedalians, fraternal organization founded by last war's flyers at Maxwell Field in '34.

All Signal Corps activities in connection with procurement, inspection, storage, and issue of communications equipment for AAF use have now been put under AAF command. Consolidation places more than 5,500 civilians and some 500 SC personnel under ATSC.

Curtiss Commandos used to "sew" 1st Airborne Army paratroopers east of Rhine featured both port and starboard doors to enable bail-outs from two sides at once.

Britain, it was revealed at press time, is going ahead with output of a huge Avro bomber which "relates to the Lancaster as the Superfort relates to the Fort." It is understood that prototype of craft has already been flown. Meanwhile, C. D. Howe, Canada's Minister of Munitions & Supply, announces that Victory Aircraft, Ltd., will make the big plane in the Dominion, tooling already being under way. Indications are that new bomber will be used against Japan. Honoring U. S., name of plane is Lincoln.

Publications: Second Report, issued by Director of War Mobilization & Reconversion, is concerned with production as relating to VE-day and post-VJ-day reconversion policies. . . Goodyear has new folder "Rubber, Its New and Increased Uses." In addition the company's part in fabrication of military aircraft is described in color-illustrated brochure titled "Air-Craftsmanship". . .Kellett Aircraft issues basic-information pamphlet "Answering Some Helicopter Questions" . . .Aviation Committee of the Glendale (Calif.) Junior Chamber of Commerce has new pamphlet describing city's airport financing and facilities and other city chambers' views on airport necessity. Title is "Glendale Is a Lucky City". . .UAC's activities are presented in brochure "A Pictorial Review of United Aircraft Corp. at War." . . .U. S. Conference of Mayors, Wash., D. C., has issued a pamphlet titled "Municipal Airport in National Airport Program" replete with fact-giving charts and tables. . .From the KLM Royal Dutch Airlines' N. Y. C. office comes "KLM's Caribbean Decade", a brochure of photos and story of company's operations in West Indies since '34. . .Third edition of "Contract Termination Manual," revised and simplified, is issued by Jack & Heintz, Cleveland, and is available to contact termination officers of other companies via business-stationery request.



LAYS PHONE WIRE FROM UPSTAIRS

No, that isn't a cannon mounted in this Douglas C-47A's door-way—it's a new device AAF has rigged up that can lay 16-mi. of telephone wire at one time from an airplane flying up to 150 mph. Key of process is method by which balls of wire are specially wound so as to control feeding action and eliminate snarling, fraying, and breaking. Wire, packed in boxes tied down diagonally across plane's floor, is led out through tube. A 20-lb. chain is attached for ballast, and when over "target", line is simply tossed out by hand to unreel. Developed by ATSC and Bell Telephone Laboratories, it is stated method will cut down casualties among men hitherto exposed to enemy fire during wire-laying missions by permitting easy bridging of tortuous terrain. (Nick Lazarnick photo)

AMERICA AT WAR

Aviation's Communique No. 40

Two outstanding events of the air war in the period covered by this report were renunciation by the Russians of their non-aggression pact with Japan, and the winning by the Americans of Okinawa, only 325 mi. from the Jap mainland.

The Russo-Jap pact does not actually expire till this time next year, but that might not prevent hostilities beginning any time. Repudiation by Russia puts the Japs in the position of having to attack soon, or wait for the Soviets to strike when they are ready. Either way is bad for Nippon.

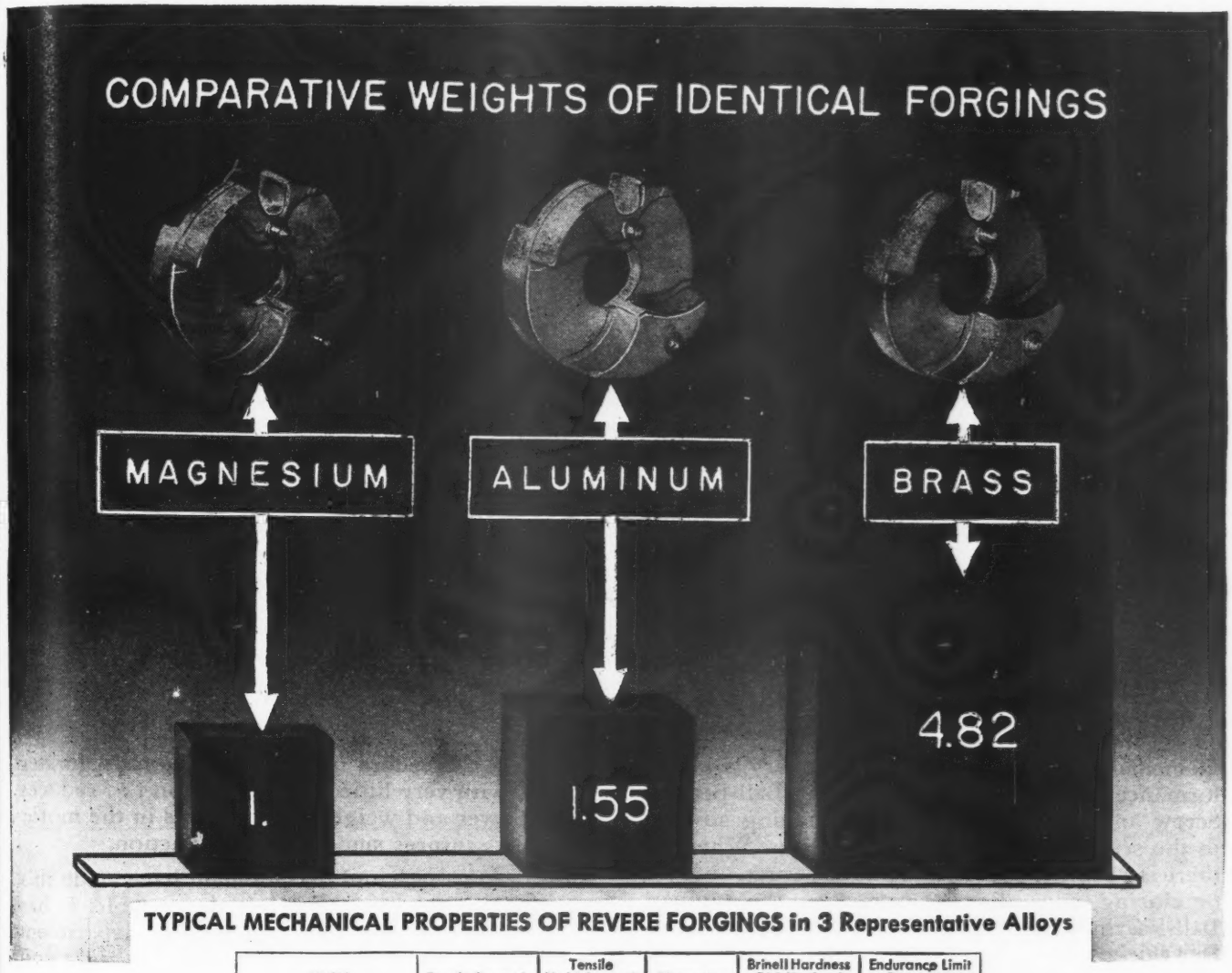
Most authorities agree that the Russians will fight the Japs. Probably very few, if any, persons know whether Russia will offer naval and air bases to the United States in the meantime. But this becomes less important as new bases like Okinawa are taken.

By bagging this 50-mi.-long island, the Army and Navy have got plenty of land on which to operate and maintain almost any amount of aviation within a range permitting heavy bomb loads and operation of escort fighters which can load up with bombs in addition to necessary fuel. Other nearer bases will be taken and, eventually, beachheads established on the Jap mainland. Gen. Arnold, Chief of AAF, recently said that every usable airplane now in Europe will be thrown against Japan. Combined air forces of British and American armies and navies may put up 10,000 to 20,000 planes against the small Empire islands on any given day.

Lt. Gen. George C. Kenney, commander of the Far East Air Force, says Japan is short of planes, pilots are poor, and best mechanics are stranded on by-passed islands. Her force has lost 10,000 planes; it is no longer a serious threat.

Rear Adm. De Witt C. Ram-

For an impartial source...see REVERE



TYPICAL MECHANICAL PROPERTIES OF REVERE FORGINGS in 3 Representative Alloys

ALLOY	Tensile Strength P. S. I.	Tensile Yield Strength P. S. I.	Elongation % in 2 in.	Brinell Hardness 500 Kg. load 10mm. ball	Endurance Limit at 500,000,000 cycles, P. S. I.
Revere Magnesium Alloy O-1 As Forged	46,000	32,000	10%	65	18,000
Revere Magnesium Alloy O-1A Aged	48,000	34,000	6%	72	16,000
Revere Magnesium Alloy O-1HTA Heat Treated and Aged	50,000	34,000	6%	72	16,000
Revere Aluminum Alloy 14S-T Heat Treated and Aged	69,000	64,000	12%	135	17,000
Revere Forging Brass Cold Struck from Hot Forged Condition	57,000	24,000	46%	63	23,000*

*At 50,000,000 cycles

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Saginaw BALL-BEARING SCREW AND NUT

Elementary in principle—revolutionary in performance—the Saginaw Recirculating Ball-Bearing Screw and Nut represents a far-reaching advance in the science of actuating mechanisms. Wherever there is a problem of elevating or lowering, opening or closing, expanding or retracting, the Saginaw Ball-Bearing Screw and Nut brings new friction-free efficiency.

Aircraft designers have been quick to recognize the importance of the Saginaw Ball-Bearing Screw and Nut in their field. It can be used to raise or lower landing gear; to actuate wing flaps, surface controls and trim tabs; to open and close loading doors or bomb-bay doors; to turn turret mechanisms; to operate wing-folding devices, and for varied other uses. Freedom from friction permits greater speeds with very little heat generation . . . reduces horsepower and weight requirements in the motor drive . . . insures smooth, positive action.

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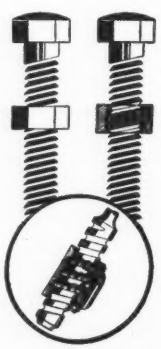
Write for free descriptive booklet on your company letterhead. Department 25-AV-5, Saginaw Steering Gear Division, Saginaw, Michigan.



THE PRINCIPLE—Unlike the ordinary nut and bolt, the Saginaw Ball-Bearing Screw and Nut has rolling balls inserted between the threads of the nut and bolt, thus easing friction and decreasing actuating effort. The balls recirculate through a special raceway (see inset). Operating effort is decreased two-thirds; efficiency climbs to 90 per cent.

KEEP BUYING WAR BONDS

Saginaw Steering Gear

DIVISION, GENERAL MOTORS CORPORATION, SAGINAW, MICHIGAN.

MANUFACTURER OF STEERING GEAR ASSEMBLIES, STEERING LINKAGE ASSEMBLIES, UNIVERSAL JOINTS AND PROPELLER SHAFTS, DIESEL ENGINE AND AIRCRAFT PARTS

sey, chief of the Navy's Bureau of Aeronautics, says air war in the Pacific is in its final phase. Naval aviation, he says, has won its duel with enemy carriers, and has helped win the island-jumping campaign. Adm. Ramsey admits our carrier losses have been heavy, but carrier warfare has been justified.

Gen. Arnold said at a recent press conference that the number of B-29's now attacking Japan will be doubled or tripled by the end of summer. He also said B-29 performance is constantly improving, and that the Superfortresses can cover 8,000,000 sq. mi., an area three times the size of the U. S. He revealed that formerly about 50 B-29's went on three missions every ten days; now about 300 go out every four days.

★ CALLING NAMES ★

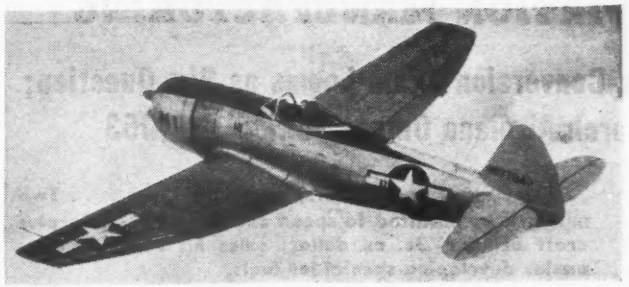
Henry P. Nelson, director of WPB's new Aircraft Div., was appointed to serve on Aircraft Production Board, where he will represent interests of commercial airlines. Other board members are **Lt. Gen. William S. Knudsen, Maj. Gen. Oliver P. Echols, Rear Adm. Lawrence B. Richardson, T. P. Wright,** and **Myron A. Tracy. Leo S. Panek** became asst. director of Aircraft Div., and **Jean A. DuBuque** is new chief of division's Aircraft Production Branch. **Jack Frye,** TWA; **Franklin Gledhill,** PAA; **Ralph Damon,** AA; and **C. Bedell Monro,** PCA, have been named to a special committee to assist Aircraft Div. in formulating a requirements program for new airplanes for airline operators.

Claire L. Barnes has been elected chairman of board of directors of Bendix Helicopter, Inc. **Robert J. Newhouse** was elected chairman of executive committee, **Frederick K. Barbour** was appointed to executive committee.

T. P. Wright, CAA administrator, has been named director of Aircraft, V-Weapons, and Light Metals div. of U. S. Strategic Bombing Survey, with **Comdr. S. Paul Johnston,** former Editor of AVIATION and later Washington representative for C-W, as his asst. Mr. Wright was recently awarded a commendation for exceptional civilian service for his work in aircraft production while director of Aircraft Resources Control Office and member of Aircraft Production Board.

Peter F. Rossman, gen. mgr. development div., C-W, Bloomfield, N. J., was elected chairman of special aircraft projects subdivision of aero div. of SAE. **E. E. Lothrop** has been appointed chairman of aviation marketing committee of American Marketing Assn. Now with C-W, he had been connected with Surplus War Aircraft div. Other members of committee are: **A. T. Hapke,** Republic; **Ross Cunningham,** MIT; **R. Rush,** All American Aviation; **A. Passen,** Harvard Business School; **E. H. Cargen,** Wright Aero Corp.; **W. L. McMillen,** AA; **L. Bollinger,** Harvard; **L. F. Hampel,** UAL; **Henry B. Moore,** Braniff; **F. Bremier,** Curtis Publishing Co.; and **J. B. Crane** of Glenn L. Martin.

Ralph C. Ayres was made TWA system supt. of communications, replacing **Gordon A. O'Reilly,** now v.-p. and general mgr. of Aero Radio of America with offices in Washington, D. C. **H. D. Fellows,** market analyst for Air Cargos, has taken similar position with TWA as senior analyst in company's cargo sales dept. marketing div. **Larry J. Vandegrift** is new company field director of industrial relations.



"N" 'BOLT HAS MORE REACH

Latest model Republic Thunderbolt is this P-47N which has a top speed of more than 450 mph. and a 1,000-mi.-plus combat radius. Featured on new fighter are larger wings with squared-off tips, added aileron area, eight more tanks which almost double fuel capacity of former P-47D, and a dorsal fin extension to improve directional stability. Armament is now ten 5-in. rockets, two 500-lb. bombs, and eight .50-cal. guns. A P&W R-2800 C engine delivers added takeoff hp., and a larger, more efficient GE CH-5 turbosupercharger has increased craft's top speed at high altitudes. Improved water injection equipment gives considerable power lift for longer periods than previously. Many controls have been made automatic to minimize pilot fatigue.

THE WASHINGTON WINDSOCK

By BLAINE STUBBLEFIELD

When Congress is asked for funds to continue civil pilot training, opposition will say that woods are already full of war-trained pilots, so why spend money to get more who cannot be employed. The answer is that most boys and many girls *want* aviation as part of their education. That will build up industry—and also build military security.

The Stubblefield Award is divided impartially among the 22 citizens who applied to the War Production Board for delivery of airplanes for pleasure flying.

The British fleet now in action against Japan, will be limited in action and effect, according to qualified opinion. It was designed for operation at relatively short ranges, with many bases. The U. S. has a three-years head start in development of the swift, long-winded carrier task forces. Of course, the British can build that kind, too, if the war lasts long enough.

A long tough battle looms ahead, between State and Federal governments, for control of the air space. A recent and powerful champion for Federal control is War Secretary Stimson. Keeping automobiles in intra-state commerce, it is pointed out, has proved a serious detriment to uniform safety regulations; trying to fence airplanes within state legal boundaries would be even less plausible.

John Lee has been named chairman of aviation committee of Los Angeles Chamber of Commerce.

John M. Martin, who has been asst. to gen. mgr. of C-W Kenmore plant, has been appointed mgr. of div. of subcontracting. His former position will be handled by **L. W. Botts.**

C. S. Gischel became mgr. of Firestone Tire & Rubber Co.'s newly created aircraft tire and accessory sales dept.

Ben T. Smith has acquired controlling stock in Southeastern Air Service, Atlanta, Ga., and he will head concern as pres.

Kenneth MacGrath was elected exec. v.-p. and a director of Air Associates, Teterboro, N. J.

Louis deGarmo has been appointed to board of consultants of NATA as public relations counsel.

Roy B. Buckley became exec. v.-p. of Timm Aircraft Corp., **Don P. Murdy** was appointed v.-p. and treas., and **Hyman Smith** became secy.

Roberts H. Ebbitts, Jr., has been named district traffic mgr. at N. Y. for Northeast Airlines.

Breeze Corp. re-elected **John T. Mascuch,** pres.; **Joseph F. Lucas,** v.-p.; and **Fred G. Shupp,** treas. **David T. Wilentz** retained chairmanship of board.

George S. Hunt, who has done design work on DC-3 and DST interiors, has resigned from Douglas to join Henry Dreyfus, industrial designer.

George D. Rash was appointed to newly created position of mgr. of schedules and tariffs for CAL, and **H. H. Cady** became company's asst. to treas.

Bradford S. Gibson has been appointed AA district traffic mgr. in Dallas, Texas.

Jack Misselhorn and **James L. Snell** are new UAL district traffic mgr.'s in Detroit and Spokane, respectively.

William A. Peek and **Arthur M. Ehler** became special asst.'s to **Arch Galbraith,** purchasing agent, and **Paul R. Whiteford,** asst. purchasing agent, respectively, of PAA's Latin American div. **Charles J. Cole** is new asst. to traffic mgr. of company's Atlantic div., with hq. at La-Guardia Field.

Lloyd Milner and **Roman Justiss,** NWA pilots who have been flying military cargo planes in Aleutians, received first Air Medals awarded to civilian pilots. **H. T. Eckstrom** was named NWA personnel supervisor for eastern region and will handle housing problems for workers assigned on N. Y. extension. **T. W. Cummins** became flight supt. of eastern area, and **Frank Martin** is named chief meteorologist at N. Y. New chief transportation agents are: **Paul Benscoter** Chicago; **C. R. Seybold,** Milwaukee; **W. F. McGoon,** Rochester; **B. J. "Red" Fitzsimmons,** Minneapolis, and **E. V. Folkstad,** Fargo.

★ TAGGING THE BASES ★

Having leased Hoosier Airport to Parks Sales & Service, Bob Shank of Indianapolis, has purchased 159 acres farther north, to be called Bob Shank Airport. His 10 yr. building plan calls for 250 individual hangers.

Otto Airlines, Newark, N. J., announces opening of new maintenance base at Blairstown, N. J., Airport.

R. B. Thompson, operator of Hines Airport, at Orla, Tex., has added lunch room and tourist cabin facilities at field. Business is reported good, since there are no hotel accommodations available within 50 mi.

Grider Field, new 800-acre airport at Pine Bluff, Ark., is being opened for business under management of Bernard DeWesse, Jr.

Bell Airport, the former Buffalo home of Airacobra, has been purchased by Mutual Aviation and will now house Empire Aero Club, which claims largest roster in State of New York. Pres. Francis Kegel says that organization is planning to operate ground and flight schools and handle repairs and service.

Gillespie Airways has leased McKellar Airport at Jackson, Tenn., including DPC plant now in use. Field will be center of routes to Evansville, Nashville, Knoxville, Chattanooga, and Muscle Shoals.

Re-Conversion Again Looms as Big Question; March Airplane Output Tallied at 7,053

. . . Navy ups plane orders, hints new types . . . Two new groups initiated to speed change-over . . . Surplus craft bring 41.3c. on dollar; sales hit . . . Oil companies developing special jet fuels.

Interest in reconversion, which was piped down with last winter's Allied reverses in Europe, is rising again as Germany is beaten down. At press time there was no specific mention of a 40 percent cutback in war production on VE day, but A. J. Krug, chairman of WPB, recently told reporters that the original cutback program, devised last summer, is still intact, with improvements, ready for use.

Krug said civilian goods in short supply will be increased during the war on Japan, and that those industries faced by difficult reconversion problems will get materials and equipment at the earliest possible moment. The reconversion program must be subject to several alternatives, depending on development of strategy in Japan, and upon needs of military occupation in Europe after Germany's defeat.

Air Forces were not ready to make any statement concerning transfer of aircraft from Europe to the Pacific theatre. Obviously the shift will be large, and the aircraft with American and British armies and navies, plus those in "pipe-lines" will be tremendous. Officials would say only that some types of military planes will be stopped entirely after VE, and some will be curtailed. But some capacity thus released will be added to other programs, such as the superbombers and jet-powered fighters.

March Plane Output 7,053

Aircraft production in March was 7,053, compared with 6,286 in February. The apparent gain of 12 percent, however, was illusory. Many March deliveries were holdovers, some awaiting better test weather, some waiting components from subcontractors. In fact, WPB's Krug said March production rate of 261 planes per day was slightly lower than in February.

Nevertheless, there was satisfaction in the fact that March unit production was ahead of schedule (6,863) for the first time in several months. March poundage was 79,200,000 against 71,000,000 in February. Bomber production was 2,544, just ahead of schedule; transports, totaling 615, missed quota by 1 percent.

Navy Ups Plane Orders, Hints at New Types

During the fiscal year 1946—beginning this July 1—Navy will procure between $2½ and 3 billion worth of new and replacement airplanes, according to Adm. DeWitt C. Ramsey chief of the Bureau of Aeronautics.

Navy is constantly improving its existing fighters and, in addition, has some entirely new designs, including jet-powered types of superior performance. They are to be in production this year, the Admiral said. Four experimental improvements on the Curtiss SB2C Helldiver are in process by different companies. Navy's new speedy torpedo plane is in production, and experimental jobs are under way.

The Admiral praised the PB4Y-2 Privateer, new version of the Consolidated B-24, and the Lockheed PV-2 Harpoon, a land-based patrol type developed from the Ventura. There is an entirely new pure-naval patrol development approaching maturity, which will replace many of the PB's now in service. The Curtiss Seahawk, a battleship-based float plane for scouting, is in volume production.

Two New Groups Initiated To Speed Change-Over

As soon as Army and Navy pressure for airplane production slacks off, WPB will be more sensitive to civilian aircraft requirements. Important evidence of this trend is recent appointment of two aviation industry committees in the newly organized Aircraft Division of WPB, headed by Henry P. Nelson.

One of these is the Aircraft Manufacturers Industry Advisory Committee, composed of senior executives of 15 companies representing the entire range of types. Other is the Airlines Advisory Committee, composed of high officials of 19 domestic and foreign-service airlines.

Surplus Craft Bring 41.3c. On Dollar; Sales Hit

Two thirds of all surplus war property now available for disposal is comprised of airplanes, airplane parts, and components, totaling almost $900,000,000 in value. After the war, aircraft and allied materials will be the biggest single block of war surplus, whose value may total $40,000,000,000, according to a recent report by OWI.

It is shown that one in every nine airplanes produced by the U. S. for this war is now worn out or obsolete. This proportion will greatly increase with victory in Europe. In the first 2½ yr. of U. S. participation in the war, only 14,500 planes became surplus; more than half of the 32,000 now surplus were reported in the past five months.

Only a small percentage of surplus warplanes are trainer, liaison, and transport types saleable for civilian use. RFC has reported that 75 percent of surplus planes on hand are marked dangerous for civilian use, and are not saleable. Planes sold so far under regulations of the SPB have brought 41.3c. on the dollar of original cost.

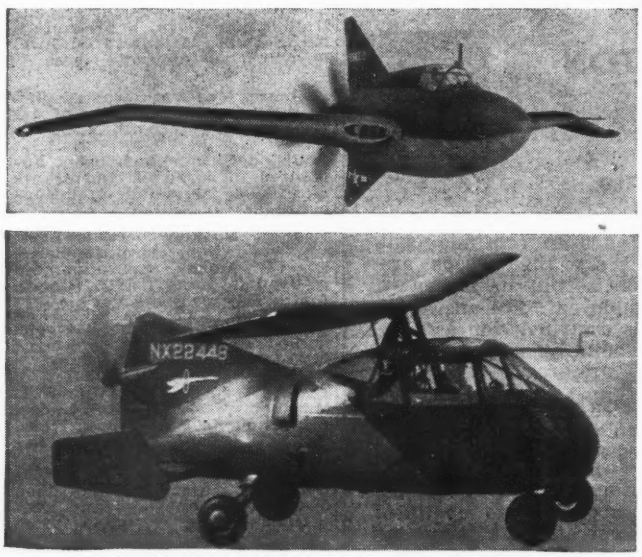
RFC is responsible for domestic surplus sales, and Foreign Economic Administration for foreign sales, both under direction of SPB. RFC's handling of surplus plane advertising has been severely criticised as misleading, and many fixed base operators feel that sales should have been channeled through them.

It is expected that a council to direct use of surplus airplanes in research projects soon will be organized, with a chairman from NACA. The airplanes would be utilized, partly at government expense, to determine breaking stresses, protection against injury in crashes, vulnerability to gunfire, fire protection, methods of ditching, belly landing, hull pressures in landing, and many others. Civilian problems would wait till after the war.

Oil Companies Developing Special Jet Fuels

Hard work is in progress toward solution of two of jet propulsion's most difficult problems. One is high fuel consumption, with resulting range limits below those of reciprocating engines. Several oil companies are making every effort to develop a special fuel for jet engines. During the initial period, jet power plants have used fuel intended for other purposes.

Another major problem is to make metals that will stand the heat and speed of jet compressors and turbines. Much progress was made in this field during years of work



TWO WINGS—CONTROLLABLE AND FLYING

Northrop XP-56 (top) is an experimental AAF fighter designed upon flying-wing principle. Aft of cockpit, a P&W engine, completely enclosed and blower cooled, turns a six blade contra-rotating prop. Elevators and lateral controls are on wing's trailing edge, while fixed vertical fins above and below the fuselage provide directional stability. Plane has a retractable tricycle landing gear.

Spratt controllable wing (above) is being tested on special fuselage by Stout Research Div. of Convair at Dearborn. George Spratt, company engineer, who is carrying on experiments begun by his father in 1903, states that this type wing will eliminate necessity of ailerons, elevators, and rudders on small craft, and also make for additional safety and easier handling of personal airplanes. Wing is adjusted manually by pilot.

on superchargers for reciprocating engines.

John F. Victory, NACA secretary, recently told the National Press Club in Washington that NACA research had boosted supercharger efficiency from 70 to 85 percent, which would greatly help in the jet field.

★ FOR THE RECORD ★

Lear, Inc., announces acquisition of space in Manufacturers Building, Grand Rapids, Mich., to house radio production and part of electro-mechanical aircraft accessory fabrication.

Carney Engineering Co., 1819 Broadway, N. Y. C., has formed Aircraft Service & Maintenance Manuals Div.

Luscombe Airplane Corp. has purchased 500-acre tract near Dallas, Tex., for erection of aircraft factory and development of new airport. Factory recently acquired in Dallas will be used immediately for storage and assembly operations.

Despatch Oven Co. announces opening of new sales and field engineering office in La Salle Wacker Building, 221 N. La Salle St., Chicago, with J. H. Watson as gen. mgr.

General Controls Co., Glendale, Calif., has announced that 3-acre factory and new office building were being readied under expansion program.

Aro Equipment Corp. has appointed Kendall Hardware-Mill Supply Co., Battle Creek, Mich., as authorized jobbers for company's industrial pneumatic tools.

Bruening-Winans Corp., which has made airframe parts, has changed name to Bruening Products Corp.

U. S. Plywood Corp. announces formation of U. S. Plywood of Canada, Ltd., to acquire assets of Hay & Co., Ltd., Woodstock, Ont., and also to conduct independent business in adhesives and other materials. D. M. Rogers, formerly associated with Hay, will manage new subsidiary.

International Telecommunication Laboratories, Inc., is new company jointly owned by International Telephone & Telegraph Corp. and its subsidiary, International Standard Electric Corp. E. M. Deloraine, general director of Federal Telephone & Radio Laboratories, New York, is president of new company.

Shell Oil Co. has opened laboratory at Wood River, Ill., for study of jet-plane fuels.

Gerotor May Corp. announces appointment of Compressed Air Products, Newark, N. J., as exclusive sales representative of its air and hydraulic devices for New Jersey and Greater New York.

Carl L. Norden, Inc., has leased building at 185-25 Northern Boulevard, Flushing, N. Y. C., for assembly plant.

★ OBITUARY ★

Vincent Bendix, founder of Bendix Aviation Corp. and president of Bendix Helicopter, Inc. Noted for marked inventive skill, he was responsible for development of many mechanical devices in field of aviation.

Lew Russell Palmer, founder and official of National Safety Council. In 1940 he was honored by a token presentation from major airlines in recognition of his contribution to promotion of safety methods which represented a lifetime of activity in fields of industry and transport.

Maurice G. McGuire, chief test pilot for Ryan Aeronautical Co. He formerly had been a naval aviator and member of Flying Tigers.

Alfred Jackson, president of Aeronautical Products, and Ohio Air Express Corp.

Alfred Reitherman, managerial executive with Spartan Aircraft Co.

LITTLE, LIGHT, AND INEXPENSIVE

GE's new 18-lb. 12-watt 2-way radio for personal aircraft is demonstrated for Piper Aircraft Pres. W. T. Piper (left) by P. G. Caldwell, sales manager, aircraft and marine div. of General Electric. Designed for low-cost production, unit features instrument panel plug-in package.

★ ASSEMBLY LINES ★

Boeing puts its fourth B-29 production line in operation at Renton plant, completing conversion from B-17 output, now completed.

Glenn L. Martin Co. delivers final B-26 Marauder on Good Friday—5,266th to be built by company.

Bell Aircraft Corp. has announced plans to close two Buffalo plants, consolidating all Niagara Frontier Div. activities at Niagara Falls plant.

Stevens Institute of Technology annual report discloses that 45 percent of its towing tank work during last year was devoted to flying boat problems.

Curtiss C-46 Commandos will be furnished China National Aviation Corp. for use over Himalayan "Hump," and three veteran pilots have been sent to Buffalo plant for detailed study of type.

Test flying: Convair's Louisville Div. test pilots have, since Sept. 1942, flown more than 377,825 mi. in some 2,200 hr. flight testing B-24's and other types, all without a crack-up or injury to flight crew member . . . Curtiss-Wright's Columbus plant's 16 test pilots test flew 107 planes—mostly SB2C's—in five days following long stretch of bad weather.

ATSC civilian employment has declined to slightly over 200,000 from peak of over 300,000 in 1943, Deputy Director Maj. Gen. Bennett E. Meyers has reported. At same time there was increase in output of engine overhaul, repair, and modification.

Westinghouse has established an Aviation Gas Turbine Div. to produce military and, later, civilian gas turbines for aircraft, V.-P. L. E. Osborne has announced. First wholly-American jet propulsion unit, developed by Westinghouse, is "expected to produce more propulsive thrust for its weight than any other aircraft engine built to date," he said.

ATSC's Eastern District announces 1945 glider production in its 11-state area will total more than $26,500,000, a gain of close to 31 percent over last year. Prime contractors are: General Aircraft Corp., Astoria, L. I.; Pratt, Read & Co., Deep River, Conn.; and G & A Aircraft Co., Willow Grove, Pa.

Ford Motor Co. has received an order for $18,500,000 of 2,000-hp. P & W engines. Company has produced more than 50,000 P & W's.

Deliveries: Menasco Mfg. Co. turned out its 75,000th hydraulic landing gear since conversion to war work in 1940. Most have gone to Lockheed P-38's, North American P-51's, and Republic P-47's . . . General Motors Fisher No. 1 plant has delivered over 8,000 B-29 engine nacelles . . . Eureka Vacuum Cleaner Co. of Detroit delivered its 200,000th electric control motor . . . Goodyear Tire & Rubber Co. produced 1,000,000th self-sealing fuel cell . . . Studebaker Corp. of South Bend has built more than 60,000 Wright Cyclone 9's usedto power B-17's.

Titled "Improvement of Labor-Utilization Procedures," 44-page bulletin (No. 807) has been published by Department of Labor for management, and it is available at 10¢ per copy from Gov't. Printing Office.

Bendix Radio Div. at Hollywood has expanded quarters to include shop facilities for assembly and production of special equipment, mockups, and experimental radio.

★ KNOW HOWS ★

Pyroxylin lacquer, buffed to high finish, is credited by maker, E. I. duPont, with adding considerably to speed of new Lockheed P-80 jet fighter.

Photo template, denoting bolt sizes by color scheme, is reported by Boeing to have saved great percent of bolting time.

Paraffin-base lubricant developed by Convair is reported to give longer drill life and least hole distortion.

Piston type air pressure clamps have been adopted by Martin plant to reduce worker fatigue and increase production.

Quartz oscillator plates are now frequency-adjusted by X-ray instead of hand rubbing, states Reeves Sound Laboratories, giving accuracy within .00001 wavelength and saving much processing time.

Flashing beacon lights which will burn unattended for a full year will soon mark high mountain peaks for military flyers. New units, developed by ATSC in cooperation with American Gas Accumulator Co., feature special baffles to prevent blowing out of lights by high winds.

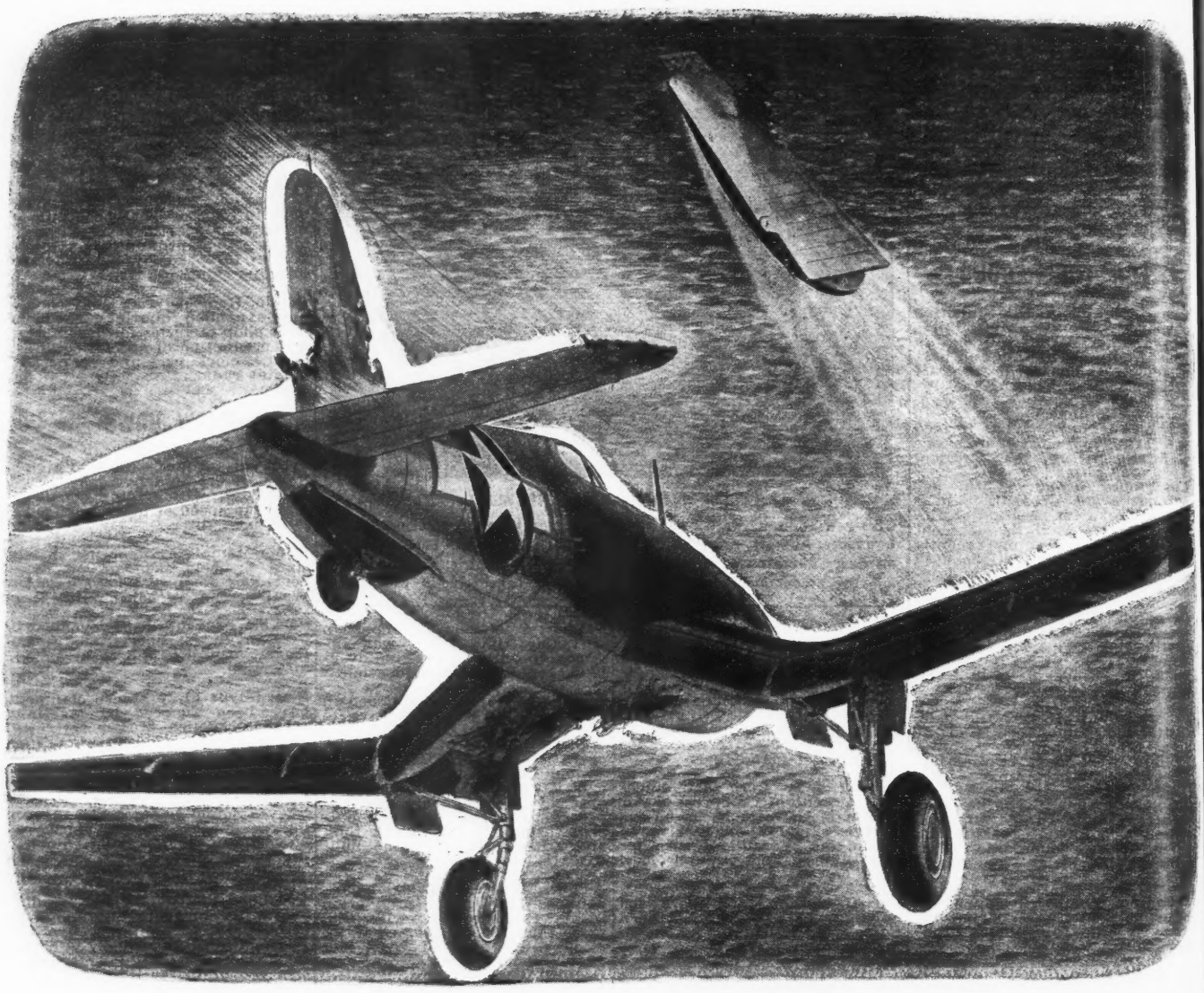
Using Triptane and lead-tetraethyl blend fuel, 12-cyl. Allison engine is reported to have developed 2,500 hp., as compared with rated takeoff power of 1,500 hp. with 100 octane gas, according to Walter Miller, v.-p. of Continental Oil.

Use of "Hessian mat" runway covering, an asphalt-impregnated burlap material which Vicksburg U. S. waterways experiment station helped develop, has speeded airstrip construction for AAF by 20 percent. Simplicity of repair is feature.

AERO CHAMBER TAB ON SURPLUS PLANES

(To Mar. 1, 1945)

Declared Surplus		Sold or Leased
	Military Types	
8,116	Primary trainers	872
6,151	Basic trainers	1
340	Advanced trainers	0
2,788	Advanced trainers (two-engine)	2
126	Reconnaissance	0
33	Reconnaissance (multi-engine)	0
1,226	Fighters	0
129	Fighters (two-engine)	0
937	Bombers	1
761	Bombers (two-engine)	1
226	Bombers (four-engine)	0
13	Rotary wing aircraft	0
1,066	Gliders	152
	Civilian types	
2,949	Liaison	1,829
5,399	WTS trainers (prewar personal planes)	5,360
190	Utility cargo	79
1,797	Light transports (two-engine)	7
214	Medium transports (two-engine)	137
1	Heavy transports (two-engine)	0
32,462	Totals	8,441



New valve gives transfusion to damaged hydraulic gear

• Many a plane has been saved from a crash by Kidde Power Actuation.

Now, a new Kidde-designed shuttle valve makes Power Actuation still simpler, still more effective.

Here's how it works.

When enemy bullets damage a hydraulic supply line, the turn of a handle releases the energy of compressed air, stored in a Kidde cylinder ... sends it through an emergency supply line.

Then the shuttle valve goes into action.

Actuated by the air pressure itself, the valve automatically switches the landing gear—or other hydraulically operated mechanisms—from hydraulic line to air line... saving an extra operation for the pilot.

Designed at the request of a leading manufacturer of Navy fighter planes, the Kidde shuttle valve is one more instance of Kidde engineering, successfully applied to the task of making combat flying safer today...as it will make *all* flying safer tomorrow.

The word "Kidde" and the Kidde seal are trade-marks of Walter Kidde & Company, Inc.

Walter Kidde & Company, Inc. • 140 Cedar Street • New York 6, N. Y.

Senate Initiates Hearings on McCarran Bill; World-Convention Treaty Also Considered

. . . WPB's Aircraft Division is now transport agent . . . SPB allocates more craft . . . Stop aircard discounts . . . Examiners favor "open" Latin America.

Hearings on the All-American Flag Line bill—chosen instrument—have been completed by the aviation sub-committee of the Senate Commerce Committee. House Interstate & Foreign Commerce Committee, which will handle the equivalent bill in the House, expected to get around to hearings in a month or six weeks. Time-consuming debate, amendments and conferences are expected to put action off till late this summer.

Sen. McCarran, Congressional sponsor of the measure, argued at hearings that American airline foreign services would have to unite to compete with the other nations' monopolized and subsidized international services. Sen. Owen Brewster (Me.) stated his belief that a forthcoming commercial air war with Britain could be alleviated by means of cooperation through the chosen instrument medium. Sen. Josiah Bailey (N. C.) opposing the bill, said it would lead to government ownership of overseas services and to heavy subsidies.

Juan T. Trippe, PAA president and leading sponsor of the All-American proposal, said that only the single management plan can enable the United States to meet foreign monopolies and thus maintain America's dominant position in the air. He said that PAA could carry all the North Atlantic traffic, which he estimated at 440,000 on the basis of steamer trade, with only eight airplanes operating in the off-season and with 11 at the summer peak. He said the trans-Atlantic fare would be $100 or less by 1950, or sooner.

Mr. Trippe praised the British single air operation, and he added that if American Export Airlines is authorized to compete against PAA on the Atlantic, as recommended by a CAB examiner, the cost of "flying American" will increase $30,000,000 a year by 1950. However, Trippe disagreed with McCarran's proposal in some detail, saying that other carriers, on land, sea, and air, should have larger representation in the proposed corporation.

W. A. Patterson UAL president and only domestic airline supporter of the Pan American plan, expressed disapproval of details of McCarran's bill, but he subscribed to the theory that "all domestic airlines assume a financial interest in the All-American carrier in order to get representation on the board of directors of such a corporation and on all technical committees, thus to keep alive the so-called 'chosen instrument.'"

Yet to be heard at this writing were the leading opposing witnesses, namely government department heads (all of whom have spoken against the corporation policy) and the airlines policy committee, representing all the domestic operators except United. They were expected to argue that, though only a few of the domestic lines want to operate overseas, they want the principle of free competition maintained, and the public will want the quality of service that can result only from competition. Press and political observers almost unanimously predicted defeat for the chosen instrument bill. If it should be passed it will probably be vetoed.

It has been pointed out several times that even if PAA loses its battle for the chosen instrument, it will still have certificates on all of the world's paying air routes. And, if domestic airlines are permitted to operate overseas, as the present law says they shall, then PAA can apply for domestic routes.

World Convention Treaty Also Considered

Inseparably bound up with the controversy over the chosen instrument policy in foreign air services is the treaty drawn up at the Chicago International Civil Aviation Conference. The document, called the Permanent Convention, provides for technical and advisory cooperation of all signatory countries in international aviation, and it takes the form of a treaty. President Roosevelt, upon request of the Senate Foreign Relations Committee, had submitted the treaty for Congressional consideration. At this writing, hearings were in progress before a Foreign Relations sub-committee of five Senators: George, Pepper, La Follette, White, and Thomas of Utah.

In the initial stage of hearings there was no indication of serious opposition to any terms of the treaty, which does not commit this country to any limitation on world routes, or to any economic control over rates and traffic. Sen. Wallace White last winter entered a resolution requesting the President to withdraw the "two freedom" commitments with other countries, but since then he has failed to muster votes in support of his stand. Opposition to the world air treaty is aimed principally at the exercise of Executive powers, not at the specific terms of the agreement.

Testifying in favor of ratification of the treaty by the Senate were:

Assistant Secretary of State William L. Clayton; Stokeley Morgan, aviation division chief at the State Department; L. Welch Pogue and Edward P. Warner of CAB; William A. M. Burden, Assistant Secretary of State for Air; Robert A. Lovett, Assistant Secretary of War for Air; Sen. La Follette, and others.

FOR OLD MEN ONLY

Airline stewardesses first took wing 15 yr. ago this month, and eight who inaugurated service for United Air Lines posed (top) beside tri-motor Boeing 80-A then used on Chicago-San Francisco run. Accompanying photo illustrates how styles in clothing have changed. . .styles in airplanes, too—if you'll just draw-w-w the eye over to the aircraft.

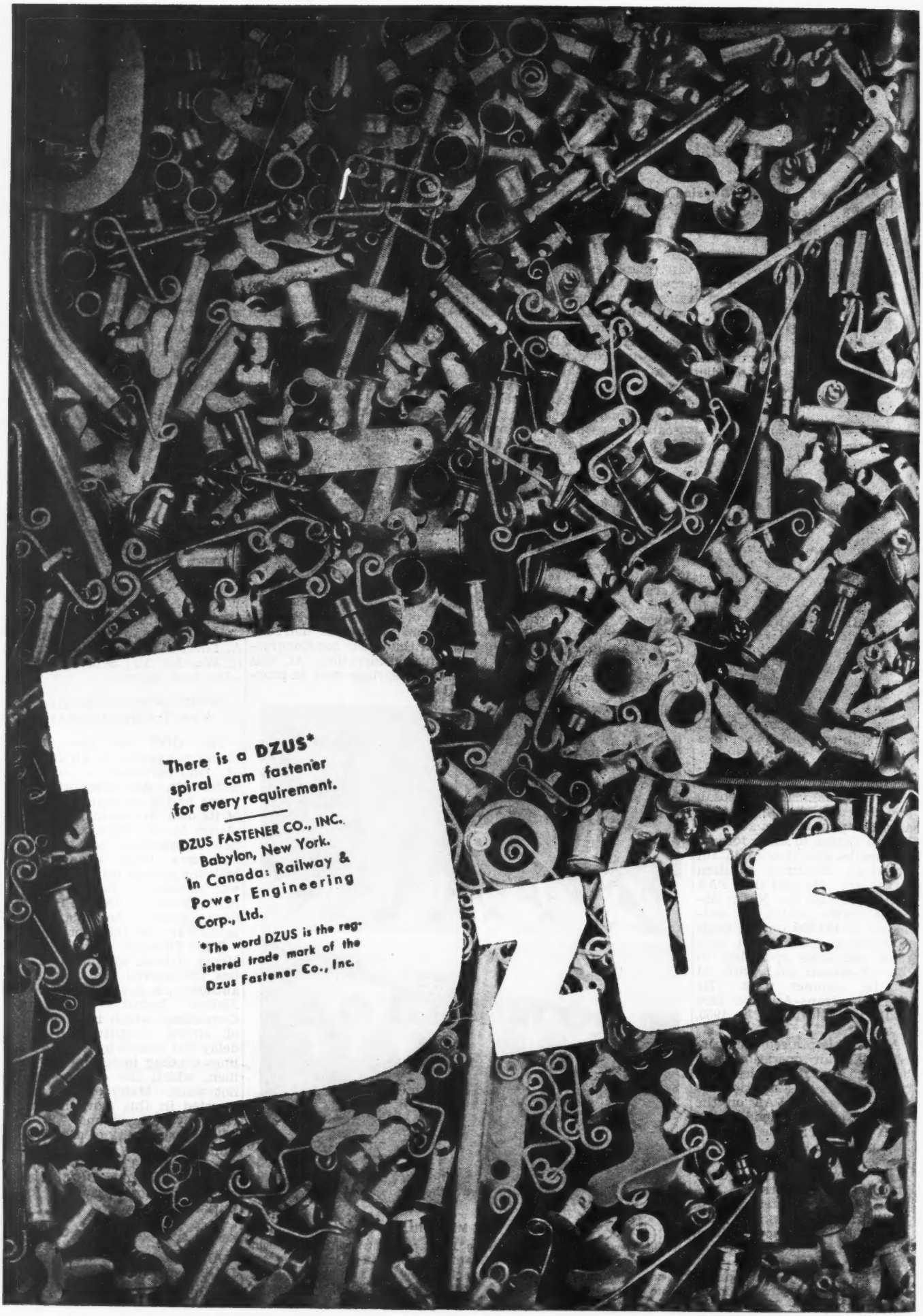
WPB's Aircraft Division Now Transport Agent

The ODT has been the claimant agency for all forms of transportation — surface water, air. Air transport had never had a claimant agency of its own, to obtain new airplanes for it. New rail cars, new locomotives, new trucks, and new ships have been built for surface transport as a war necessity. But now the Aircraft Div. of the WPB has been made the claimant agency for air transport.

The Division, headed by Henry Nelson, to whom ODT has transferred the claimant authority, is working with the Airline Industry Advisory Committee, which is made up of airline executives. Some delay was caused by a few airlines sending in second string men, which the division did not want. Many officials interested in this move believe that, by late summer, WPB will order delivery of a limited number of new airplanes to the airlines. The opinion was expressed that new DC-3 types would be most practical for initial release.

SPB Allocates More Craft

Allocation of six additional DC-3 type airplanes by the SPB to the airlines brings the total (since SPB took over last


There is a DZUS* spiral cam fastener for every requirement.
DZUS FASTENER CO., INC.
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In Canada: Railway & Power Engineering Corp., Ltd.
*The word DZUS is the registered trade mark of the Dzus Fastener Co., Inc.
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December) to 81, including 8 Lodestars. Counting those planes returned to the airlines by the Army, before December, returns now total about 215. But from this number must be deducted some replacements of unrecoverable crashes, some for cargo service only, and 16 assigned to Pan American, Panagra, Hawaii, and Alaska.

Lodestar craft are assigned mostly to cargo carriers and to non-airline users, such as war plants. At this writing, 24 Lodestars had been assigned to domestic users, and 14 to foreign users, mostly airlines. Forty-four DC-3's had been assigned to foreign applicants, mostly airlines.

Stop Air-Card Discounts

CAB recently suspended 5 percent discounts on air travel cards and government travel orders, which were to have gone into effect in late March. Hearings were called and final action will have to be taken before the order expires in late June. The Board had ordered major airlines to show cause why their airmail rates should not be drastically reduced, and in recent months it then suggested that lower passenger fares might be in order.

Many of the airlines are reducing their passenger fares. But the discount suspension is a different matter. The Board is contending that the discount (which used to be 15 percent is discrimination, in favor of travel card holders, against those who must pay cash.

Examiners for "Open" L.A.

CAB examiners, reporting on the Latin American group of foreign service airline applications, recommends numerous airlines in the Caribbean and South America. These would compete against PAA. Report argues for quality and efficiency of service through competition, and it rejects PAA's request for exclusive rights in SA. Examiners repudiate the chosen instrument theory, also are rejecting applications from steamship companies. They call for foreign extension of several domestic airlines.

★ CROSS COUNTRY ★

SPB allocations: Woodley Airways, Alaska; Peck & Rice Airways, Alaska; UAL, AA; TWA; each received one DC-3. SPB chief of aviation division, Lt. Col. William B. Harding, announced his office is starting studies to find out what conversion costs of Douglas C-54 will be.

Air imports of strategic materials into U. S. last year totaled 7,133,000 lb. an increase over '43 of 166,000 lb An additional 33,766,000 lb were flown over "hump" and sent to U. S., Britain, and Russia.

NAL Lockheed Lodestar recently made Flordia coast-to-coast record of 25 min. from Daytona Beach to Tampa, flying at 302 mph.

Douglas C-54's are in operation on 1,000-mi. line from East Bengal to Kunming China, hauling 7½ ton, of cargo per trip in addition to enough fuel for round trip.

Western Air Lines began direct daily mail and express air service between Denver-Los Angeles, with intermediate stops at Las Vegas, Nevada, and Grand Junction, Col. At present no passengers will be carried on the runs.

Survey is being conducted by Fairchild Aircraft div. and Evans Transportation Research, in cooperation with Dept. of Agriculture, on moving of perishables by air from Florida to N. Y. Fairchild is supplying payload and per-ton-mile cost data.

TWA's first re-modeled Boeing Stratoliner went into service Apr. 1. Company owns five of these craft which originally cost $350,000 each but repurchase and modifications are understood to have run price up to $400,000 . . .Company is lowering fares over entire system, with average about 10 percent . . ."Visual" method of checking on seat-space has been extended by airline to cover entire system.

AEA reduced risk insurance premiums on cargo, offering saving of up to 3¢ per $100 on both local and non-stop trans-atlantic shipments.

AA revised all N. Y.-Boston schedules and now offers hourly departures from each city.

Postwar preview of air shipment of latest apparel styles by Brighton Mills, Miss Hollywood, Jr., and Renoir Fabrics inaugurated a "Fashions in Flight," with sending of finished fabrics via AA Flagship Airfreighter from N. Y. C. to Los Angeles.

Frozen food process, devised by W. L. Maxson, involving partial pre-cooking, freezing and, when food is to be served, final cooking, is now under study by airlines as method of serving meals in flight. System is now used by NATS.

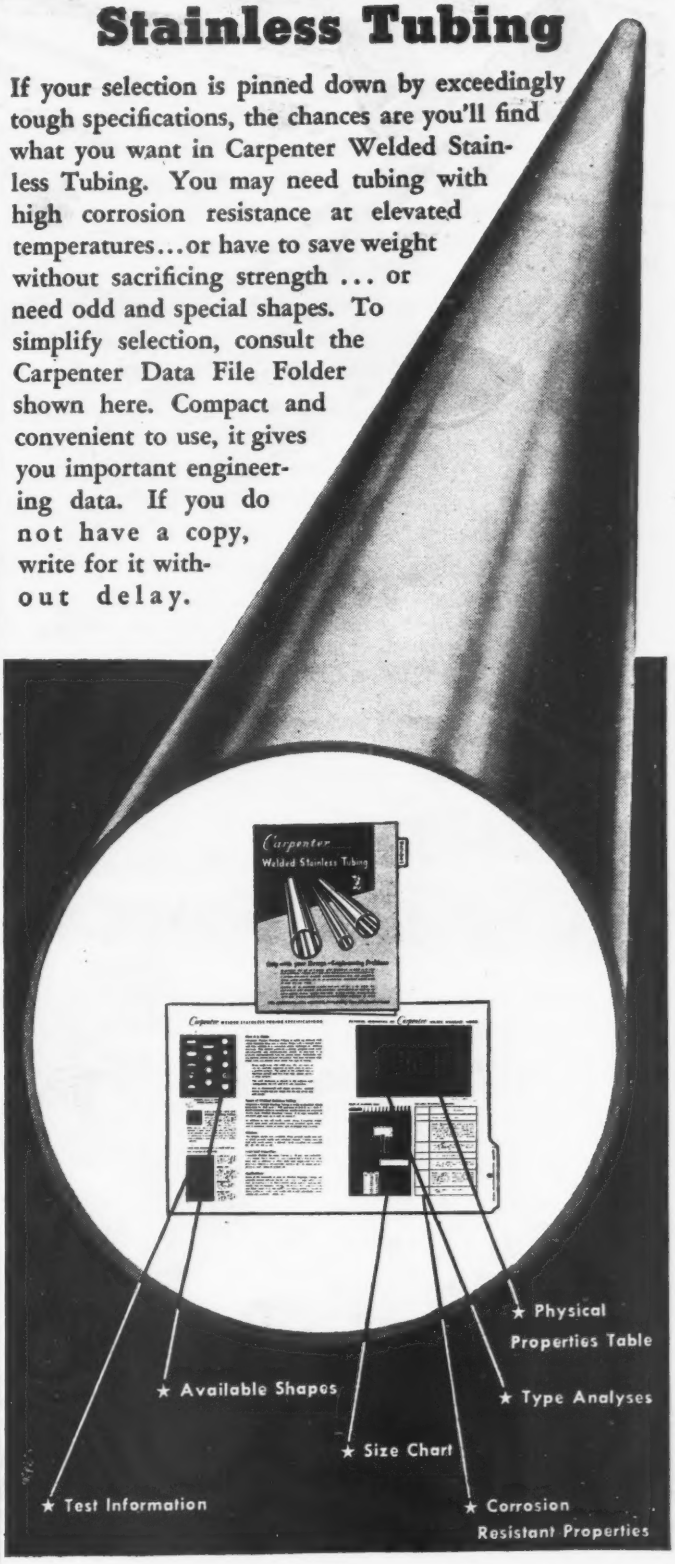
PAA has opened three new schedules over Caribbean between Colombia, Panama, Puerto Rico, and Barranquilla, Colombia, and Miami, Fla. Two direct services daily, Balboa-New Orleans, bring number of weekly Panama-U. S. flights by PAA to 28 . . . Company operated ATC Lockheed Constellation broke own non-stop record from Los Angeles-Miami by 38 min. with new flight time of 8 hr. 5 min. . . . Airline's flight mechanic's school operated for NATS will close this Aug. after nearly 2½ yr. of operations . . . Company made 5,000th Atlantic crossing for ATC.

PCA acquired facilities in Ritz Towers Hotel, N. Y. C., for additional mid-town ticket office and traffic hq. to augment reservations work. Airline expects to operate flights into N. Y. early in June.

NWA has added to its facilities with establishment of new quarters in N. Y. C. Information Center, 42nd St. and Park Ave., to serve for pickup terminal and ticket sales. Company also opened new ticket office at 616 S.W. Broadway, Portland, Ore.

Here's Help in Selecting Stainless Tubing

If your selection is pinned down by exceedingly tough specifications, the chances are you'll find what you want in Carpenter Welded Stainless Tubing. You may need tubing with high corrosion resistance at elevated temperatures...or have to save weight without sacrificing strength ... or need odd and special shapes. To simplify selection, consult the Carpenter Data File Folder shown here. Compact and convenient to use, it gives you important engineering data. If you do not have a copy, write for it without delay.



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FROM THE PROVING GROUND OF WAR

Out of the gruelling tests of battle and the exacting demands of present-day military aviation have come many advancements in engine carburetion. Holley research has pioneered a number of these developments . . . as it has done for nearly a half century in carburetors for automotive, aviation and marine uses. When the war is won, look to Holley for continued leadership and even greater dependability of performance. The proving ground of war has made better carburetors for peace.

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CARBURETORS AND ACCESSORIES

German Industry's "Swan Song" Craft

. . . They were modified FW-190, Dornier fighter, and Arado jet job.

Germany's aircraft industry, even while in its death throes, came up with two additional new fighters, and one modification.

The modification was the FW-190D, a Focke-Wulf 190 equipped with a 2,000-hp.-plus Junkers 213 engine enclosed in a long cowling. With addition of that long nose, constructors had to lengthen the fuselage some 3 ft. and add considerably to the vertical tail surfaces to maintain stability.

This new type, existence of which was definitely confirmed, is distinct from FW-390 with the DB-603 engine, of which apparently only one prototype had been constructed.

Dornier had been testing a new fighter, with two engines in tandem, known as the DO-335, and in appearance very similar to the Fokker D-23. The pilot sits between the engines in a central nacelle—an undesirable position in crash landings, as was found in the D-23, which saw some military action when the Nazis appropriated a number of them in Holland in 1940.

Other new fighter is a jet-powered plane—the Arado AR-234. It went into action against the AAF, but little had been divulged about it at this writing.

★INTERNATIONAL BRIEFS★

Need for more knowledge of airline facts among world's legislators was evident in recent debate in House of Commons when Mr. Perkins, one of the members, stated that Pan American had no airlines outside U. S. before war. Perhaps PAA should send Mr. P. a 1941 timetable.

KLM Royal Dutch Airlines has been assigned three surplus Douglas DC-3's. They will be placed in service in West Indies, probably between Miami and Curacao.

Salvage units of British Fleet Air Arm recovered more than $6,000,000 worth of aircraft per month during the past 5 yr. of operation from Scotland. Records show that 25 percent of engines come through crashes Okay, and 95 percent of propellers can be put back in service.

Reports from Germany state that, when Allied troops approached, famed dirigible Graf Zeppelin was destroyed by Nazis, together with its newer and larger sistership.

Aerovias Braniff, subsidiary of Braniff Airways, has opened first of its Central American routes. Line operates DC-3's between Mexico City and Nuevo Laredo.

Royal Norwegian Air Transport is Norwegian Government's new organization for preparing resumption of civil aviation in that country. RNAT is now purchasing equipment in this country, and it is training personnel both here and in Canada.

Management of KNILM East Indies Airways is preparing to return to Indies via Australia to attempt to re-establish its air routes in that area. Company, which sold all its aircraft to Australia-based U. S. Army, so far has not obtained any new equipment.

★ CANADIAN NOTES ★

By James Montagnes

Canadian War Assets Corp., Montreal, government-owned company for war surplus sales, offered latest list of 717 aircraft, including 325 DeH Moths, 100 Lysander reconnaissance craft, 150 Anson bomber trainers, 59 Cessna Cranes, 50 Oxford trainers, and other larger transport type planes. Also offered were more than 1,000 engines of various makes.

Final graduates of British Commonwealth Air Training Plan have completed their courses, bringing total aircrew men turned out by plan in Canada to 130,000.

J. A. Wilson, director of air services, Department of Transport, Ottawa, has been awarded McKee Trophy for 1944 for outstanding contribution to Canadian aviation and assistance in development of international aeronautics. He has been chief of civil aviation since 1918.

Canadian Air Transport Board, formed in late '44, has begun operations and issued directives and regulations. Applications for commercial transport licenses are being accepted at the Ottawa headquarters under Chairman R. A. C. Henry.

Victory Aircraft is now producing one Lancaster bomber daily. The 300th Lancaster was produced late in March.

Reduction in passenger fare on Trans-Canada Air Lines' nonstop Toronto-New York run has gone into effect. Holders of air travel cards—there are now about 7,000 in the Dominion—are granted 15 percent discount from regular one-way fare, while those purchasing cash round trips get 10 percent discount.

By F. H. Fullerton

Air service for Okanagan Valley is possibility if tentative proposals for service between Kamloops and Vancouver are completed. At former city, negotiations are under way with Inter-City Airlines to operate this route.

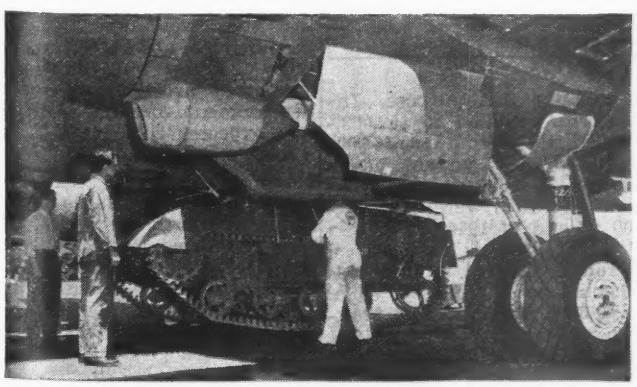
WORLDATA . . . . . By "VISTA"

According to London reports, the nearly 50 percent increase in the airplane fleet of BOAC during '44 brought about an equivalent increase in traffic. This is certainly notable. Building up from 107 planes to 151, the company flew some 19,000,000 mi., carried 100,900 passengers, 6,560 tons of cargo, and 1,980 tons of mail. Among company craft are some 55 Dakotas (C-47's), 22 Sunderlands, and 5 Yorks. Delivery of 32 Lancastrians is awaited.

England has come up with a postwar airline program which establishes a "chosen instrument" of sorts, even if consisting of three separate companies. While so far little information has become available, it is known that there will be three British companies, each to operate in a specific area on a non-competitive basis with the other two. There will be a joint organization for the training of personnel and maintenance of aircraft, while it is also understood that sales offices in different parts of the world will be joint. Both BOAC and British steamship companies will play a prominent part in the new companies, while it is expected that the British Railways, operating through Railway Air-services, will control most of the internal services in the British Isles.

So apparently the pressure on the British Government for a definite policy has borne fruit, and little change is expected in the actual postwar organization. Moreover in the mere fact that they now have a definite policy, the British are ahead of us, their companies now being able to select aircraft and prepare for early operation after peace. While not directly connected with these plans, another instance gives further indication of British aims—namely the report that permission will be refused English airlines to purchase American equipment, with virtual order that all companies replace American equipment as soon as possible with planes of British manufacture.

Commercial airlines in Europe were still struggling to regain their footholds, but with little success, at this writing. Sabena, the Belgian line, had hopefully announced reopening of its service to the Belgian Congo, but the first plane, with many officials on board, has been held up at Algiers, lacking permission to continue. Apparently because of sparse traffic, the Swedes halted all air services between their country and Fihland until further notice, their only international runs now being over the Stockholm-England route. Meantime, Portugal started to extend the runways at Lisbon preparatory to receiving bigger airliners from both America and Britain, and Spain entered into an agreement with the U. S. for the construction of a large airport at Madrid, presently for military transport aircraft, and eventually for civilian uses.



AERIAL REMORA

T-9 tank is hoisted by hydraulic pump to be locked in special rack under belly of Douglas C-54 Skymaster for quick transport to battle zone. During tests, tank has been loaded and takeoff made within 6 min. Douglas and ATSC collaborated in developing racks for field guns as well as tanks.

Douglas Aircraft reports net sales of $1,061,407,485 for fiscal year ended Nov. 30, 1944, compared with $987,687,196 in preceding year. Net income was $7,685,227 or $12.81 a share, against $5,952,257 or $9.92 a share a year earlier. Sales were 38 times 1939 volume. Cancellations last year were nearly $500,000,000 with no final settlements yet made. Net income was less than 0.75 percent of total sales volume.

United Aircraft reports 1944 net profits of $15,562,335 or $5.37 a common share, against $15,396,114 or $5.30 a share in 1943. Despite change-overs to more advanced models in every division, sales were $743,527,683 against $733,590,668 in 1943. Not included in 1944 sales were shipments of $90,000,000 from Missouri plant, which is operated for the government without profit or loss to company. Current assets at end of 1944 were $182,675,000 and current liabilities were $88,675,000. Net profit on sales was 1.7 percent last year. Postwar reserves now have reached a total of $35,201,000.

Unfilled Orders: North American Aviation, $845,000,000; Aviation Corp., $37,000,000; Douglas, nearly $2,000,000,000; Consolidated Vultee, $1,700,000; Republic, $600,000,000; and Ryan, $103,000,000.

Lockheed Aircraft reports 1944 net profits of $4,522,848 or $4.20 a capital share against $7,988,420 or $7.42 a share in 1943. Net sales were $603,363,664 against $669,162,490 in 1943. Ratio of net income to sales was 0.75 percent compared with 1.19 percent previous year. Current assets at 1944 year-end were $161,969,497 and current liabilities were $138,186,174. Army orders for Lockheed's P-80 Shooting Star jet-propelled fighter, according to Pres. Gross, call for largest program in planes per month ever assigned a single airframe manufacturer.

Republic Aviation Corp. reports 1944 sales of $369,593,425, an increase of $87,011,738 over 1943. Plane deliveries totaled 6,989 at an average cost of $43,000 in 1944, against 4,157 planes averaging $54,490 in 1943. Net profits, according to Pres. Alfred Marchev, were $5,141,490 or $5.23 a share against $4,869,954 or $4.95 a share in 1943. Reserves for postwar readjustments now total $3,942,279. Republic will offer "multi-engine carriers" for postwar delivery in commercial transport field.

Adding It Up.....By Ray Hoadley

Airline Dividends. Eastern Air Lines has joined the ranks of lines paying regular dividends to their stockholders, with a 50c. disbursement. Shortly before the war Pan American was the only line making regular payments, but now there are others which not only are maintaining dividends but also continuing to strengthen their working capital position at the same time. The strong balance sheet position of Eastern testifies to the wisdom of withholding dividends until a company's asset position is sufficiently fortified to withstand the strains of broad postwar expansion.

Sub-contractors. Government officials and bankers, too, are no longer particularly worried over the contract termination outlook for the primary manufacturers, but they still are considerably concerned over the situation of the sub-contractor when cancellations flock in. To the surprise of most government officials, relatively few concerns have availed themselves of the opportunity to take out T-loans.

Commercial Orders. Douglas Aircraft has orders on its books for $129,000,000 worth of commercial transports and, what is equally as important, has as much more under negotiation. Thus this famous transport builder has almost twice as much business in sight today as it had in unfilled orders five years ago, when the French and British were contracting for all the planes that Douglas and several other American manufacturers would agree to sell.

Transport Contracts. However, there are two factors involved in this big commercial order backlog that Pres. Donald Douglas was careful to point out to stockholders in his recent annual report. If manufacture is delayed beyond the date tentative set for delivery, or the price is substantially higher than the amounts tentatively set, the airlines can cancel the contracts.

Conditional Agreements. Lockheed, too, has previously unannounced commercial orders far in excess of $150,000,000 for transports. But Pres. Robert Gross takes pains to point out that it would be misleading to imply that the volume of such conditional agreements indicates "a true backlog of postwar commercial business."

Stock Market Rumors. Strength in several aviation stocks recently brought a flood of rumors to explain the sudden activity. Curtiss-Wright was said to be buying up the minority interest in its subsidiary, Wright Aeronautical—but company officials denied it. Eastern Air Lines was reported as eyeing the half interest in Pan American-Grace Airways held by the Grace group, and Grumman was thought to be planning a stock dividend. Activity in TACA airlines was attributed to the probability of near-term financing.

American Airlines has no definite plans for issuing new preferred and common stock authorized by stockholders last year. Net profits in 1944 were $4,396,163 or $3.41 a share against $3,192,969 or $5.18 a share on a smaller capitalization in 1943.

Glenn L. Martin Co. reports 1944 sales of $533,400,444 against $598,072,796 in 1943. Net income was $4,909,572, equal to $4.37 a share, against $2,988,456 or $2.68 a share in 1943. Annual report showed that $14,500,000 was added to contingency reserves last year, making total reserves of $24,500,000 for this purpose. Inventories declined to $52,903,000 in 1944 from $95,166,000 in 1943 while current assets totaled $198,682,000 and current liabilities were $181,306,000 at end of 1944.

Aeronca Aircraft reports 1944 net income of $205,956, equal to $1.31 a share, against $204,546 or $1.55 a share in 1943. Net sales last year were $4,548,322 compared with $4,574,402 in 1943. Pres. John W. Friedlander said arrangements would be made for a "T" loan to finance any war contract termination if such should occur.

Dividends: Ryan Aeronautical Co. recently declared a special dividend of 15c. a share. Pres. T. Claude Ryan said that although it was company policy to consider dividends near end of year, 1944 fiscal year earnings justify special dividend. . .Eastern Air Lines has placed its stock on a $1 yearly dividend basis with payment of an initial semi-annual dividend of 50c.

Thompson Products reports 1944 net earnings of $2,906,312, equal to $7.45 a common share, against $2,304,148 or $7.21 a share in 1943. Net sales were $133,256,120 in 1944, of which $52,228,000 came from aircraft products subsidiary. In 1943 net sales were $133,153,000, of which $53,538,000 were made by the aircraft subsidiary.

Airline Earnings: United Air Lines reports 1944 net profit of $6,114,991 or $3.79 a share against $3,203,276 or $2.13 a share in 1943. . .Transcontinental & Western Air reports 1944 net profits of $2,752,960 or $2.82 a share against $2,050,891 or $2.12 a share in 1943 . . .Braniff Airways earned $773,985 or 77c. a share last year, against $542,024 or 54c. a share in 1943. . . Pennsylvania-Central Airlines reports 1944 net profit of $404,635 compared with $279,733 previous year. . .Eastern Air Lines reports 1944 net profits of $1,499,337 or $2.54 a share against 1943 net profits of $1,426,859 or $2.42 a share.

Western Air Lines has been listed for trading on N.Y.C. Stock Exchange. Net profits for 1944 were $135,828 or 33c. a share, against $90,194 or 22c. a share in 1943.

Insurance Co. of North America has set aside $2,500,000 for development of aviation insurance. Company officials say step was taken to be prepared to absorb extraordinary losses and expenses that may arise out of rapid development of this business now expected.

Northrop Aircraft has received $65,000,000 in new war orders. Earnings for six months ended Jan. 31 were $361,534 or 90c. a share against $603,516 or $1.50 a share in fiscal year ended July 31, 1944. Net sales for six months ended Jan. 31 were $46,896,000.

Kellett Aircraft had sales of $11,839,807 in 1944 compared with $11,297,106 in 1943. Net income was $143,908 or 33c. a a share against $48,739 or 11c. a share in 1943.

Sets New Standards for DEPENDABILITY *and* ECONOMY

FLYING Curtiss Commandos 10,000,000 miles, largely over water to South America and Africa, Eastern Air Lines pilots, operating for Air Transport Command, never missed a scheduled flight because of adverse weather conditions.

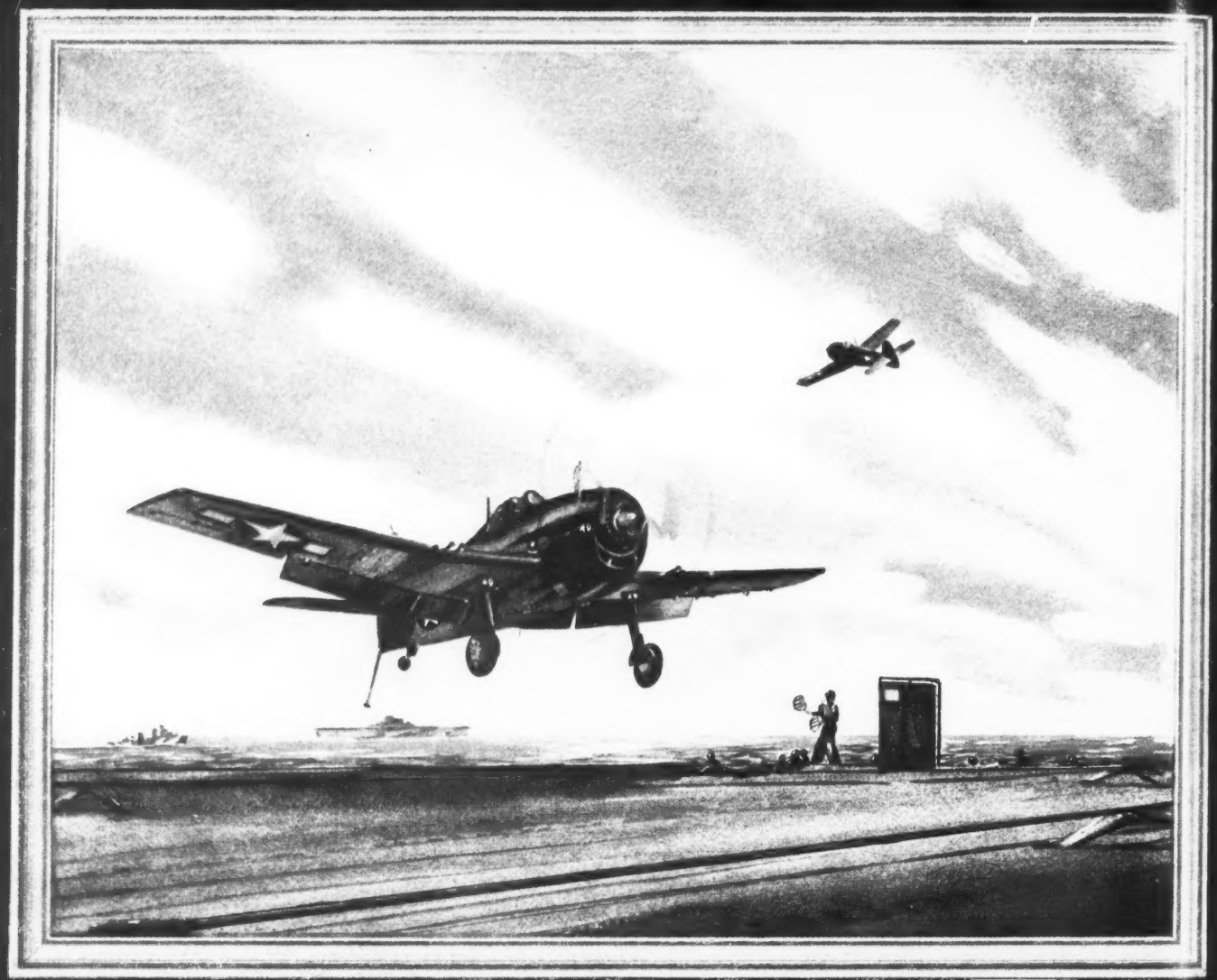
That's equal to 400,000,000 passenger miles, but it is only a small portion of the tough war mileage which has tested and proven the Curtiss Commando to make it the most advanced transport available for peacetime air fleets of the world.

World's largest and fastest twin-engine passenger-cargo airplane, the Commando will seat from 36-42 passengers, yet have 526 cubic feet of cargo space to accommodate anticipated 1400% increase over the prewar level in mail and cargo during the immediate postwar years.

With its twin-engine economy, the Commando will produce profits when flying with far less than maximum payload—show greatly accelerated revenue as payloads approach or attain full capacity—is the most economical airplane to operate on flights whose range accounts for more than 90% of all domestic air travel. Curtiss-Wright Corporation, Airplane Division.

Curtiss Commando

Passed the toughest tests ever given a Transport Plane



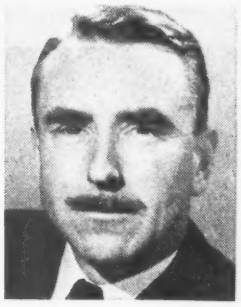
U. S. Navy's Grumman Hellcats Return from a Raid

Grumman

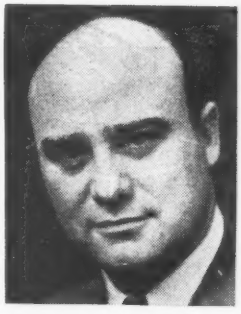
AIRCRAFT ENGINEERING CORPORATION, Bethpage, L. I., N. Y.

ROBERT H. KITTNER has joined Glenn L. Martin as mgr. of company's new plastics and chemicals div. He will take complete charge of development program of Marvinol products, new Martin elasto-plastic. Previously he had been with American Hard Rubber Co., as company engineer.

LT. COMDR. F. WEBSTER WIGGIN is new gen. mgr. of Embry-Riddle School of Aviation's seaplane base in Miami. Recently released to inactive duty after being connected with naval flight training for past 3½ yr., he returns to position he held prior to entering naval air service.



KENNETH CAMPBELL won SAE Wright Brothers' gold medal for his paper "Engine Cooling Fan Theory and Practice". Recently he was made advance projects research engineer. (Fan cooling articles by Mr. Campbell appeared in July and Aug. '44 Aviation) (Chilton-Butler photo)



D. ROY SHOULTS, formerly engineer of GE'S aviation div., has joined Bell Aircraft Corp. as v.-p. of sales. Because of his interest in jet propulsion and turbines he will be closely connected with this program at Bell. He will coordinate sales activities of firm's three divisions.

SPENCER J. LEECH has been made exec. asst., acting in capacity of asst. to Jim Welsch, sales director of Convair's Stinson div. Mr. Leech will be concerned with organization of company's postwar distributor setup. His airplane selling career began in 1933 when he organized Leech Aircraft.

A. R. MARSHALL, USN, retired, became chief of industrial relations dept. of Convair's Stinson div. A veteran of World War I and II, he comes to Stinson from company's Nashville div., to which he transferred in '39 from Vultee Field, Calif. In '42 he left Nashville div. for service with Navy in Pacific area.

E. E. ELLIOT, veteran Navy pilot for 12 yr. and recently chief test pilot for McDonnell Aircraft Corp., has been made a flight service engineer at Fairchild Aircraft div. and will act as field representative of company at AAF bases where C-82 Packet is in operation. He left naval service in 1940.

MARVIN J. PARKS is new flight service engineer with Fairchild Aircraft div. in Hagerstown, Md. He will work in setting up a liaison system between company's plants and AAF flight crews who will fly C-82 Packets, making available technical data necessary for successful operation of this plane. He was formerly with C-W.

EDWIN A. LINK, inventor of famed Link aviation trainer, received Potts gold medal of The Franklin Institute for 1945 in recognition of valuable contributions in field of air training devices. His first trainer was completed in '28 and by '41 factory personnel was 50 times what it had been 5 yr. earlier.

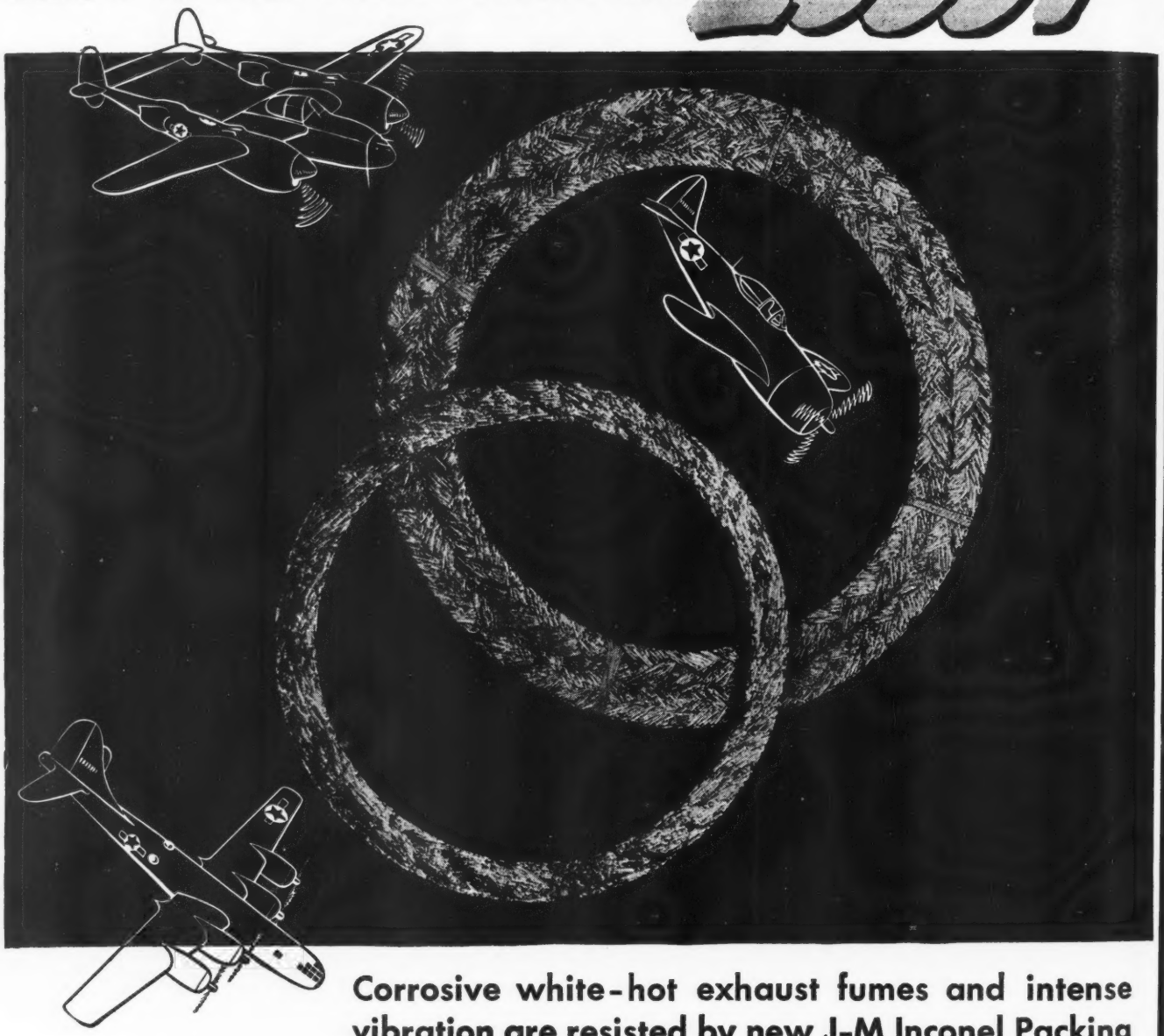
HOWARD S. CULLMAN, of Cullman Brothers, Inc. has been elected to board of directors of Aeronca Aircraft Corp. He is also chairman of Port of N. Y. Authority, pres. of Beekman hospital and a director of Lawyers Trust Co. He was head of '45 Red Cross and War Bond drive in tobacco industry.

JOHN L. COHILL became pres. of Firestone Aircraft Co. Associated with Firestone for 20 yr., he has served as company's v.-p. since 1942. He studied at Carnegie Institute of Technology, England's Royal Military Academy, and Oxford. He also served as a capt. in British Army during World War I.

RAYMOND P. LANSING (left) was elected a director of Bendix Aviation Corp. He is a v.-p., a group exec. of corp., and a member of its administration and policy committees, also he played prominent part in development of Eclipse-Pioneer div. As group exec. he is in charge of Eclipse-Pioneer and Scintilla divisions. ARTHUR C. OMBERG (center) has been appointed chief research engineer of Bendix Radio div., where he will be responsible for all of company's long term development and electronic research in radio, radar, and television. Formerly asst. chief of U. S. Army Signal corps, he supervised studies of all types of radio and radar in European and Pacific combat areas. DR. HAROLD GOLDBERG (right) has been made Bendix Radio div. research engineer. Formerly senior engineer with Stromberg-Carlson, he is a graduate of University of Wisconsin, where he was a Post-Doctorate Fellow in biophysics, research, and electrophysiology.

ARTHUR A. PIEPER was elected financial v.-p. of Republic Aviation Corp. He has had long experience in corporate finance and accounting with International Harvester Co., Price Waterhouse & Co., and Arthur Anderson Co. He joined Republic a year ago as asst. to pres. in charge of accounting and auditing.

This J-M PACKING WITHSTANDS 2000°F



Corrosive white-hot exhaust fumes and intense vibration are resisted by new J-M Inconel Packing

THE CORROSIVE EXHAUST that blasts out from today's warplane engines hits a temperature top of around 1700° F. Its destructive attack on packings used to seal exhaust manifolds is stepped up by intense vibration.

An answer to this triple threat combination of white heat, incessant "shivering," and severe corrosion is found in a new packing, developed by Johns-Manville engineers.

Made of fine Inconel wire ... a nickel-chromium-iron alloy ... first knit into mesh, then tightly braided, these J-M Packings stubbornly resist the corrosive attack of searing gases. Highly resilient and flexible, the J-M Inconel Packings cushion the vibration between moving and stationary parts of the exhaust systems...on B-29's, B-32's, P-38's, P-47's and other planes. Expansion joints are tightly sealed, even in the stratosphere; dangerous gases are prevented from seeping into the plane.

Scores of packings for all industry are on the Johns-Manville list. Many have been specifically designed to fill Aviation needs and will provide added service life for post-war engines, propellers and exhaust systems.

For full information write Johns-Manville, 22 E. 40th St., New York 16, N. Y.

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Packings and Gaskets • Friction Materials
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INFORMATION TIPS

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Attitude Gyro.....1

Publication 15-37 from Sperry Gyroscope Co., Great Neck, N. Y., is informative color booklet detailing operation and construction of attitude gyro, which provides pilot with precise visual indications of his plane's position through full 360 deg. (See page 208 Sept. '44 AVIATION for photo and description of instrument.—AVIATION, May '45.

Actuating Equipment.....2

Booklet, *Lear Know-How*, from Lear, Inc., Piqua, Ohio, describes present and potential applications of company's rotary actuators, power units, flexible shafting, automatic and remote control and positioning "Fastop" clutch, screw jacks, and precision gears.—AVIATION, May, '45.

Die Casting Design.....3

Designed to help users of die castings, 64-page booklet from New Jersey Zinc Co., New York City, covers principles for designing and many engineering details.—AVIATION, May, '45.

Water-System Air Control.....4

For use on water storage tanks of shallow well pneumatic water systems, new air control is described in circular from Manning, Maxwell & Moore, Bridgeport, Conn.—AVIATION, May, '45.

Tractors 5

Caterpillar Tractor Co., Peoria, Ill., has issued booklet, *Over 50 Years of Leadership*, listing various types of tractors and recording performances.—AVIATION, May, '45.

Strengthened Metals.....6

Process of "Rigidized" controlled redistribution of metals is topic of booklet from Rigid-Tex Corp., Buffalo. Scientific distribution throughout cross-section and away from neutral axis is described as giving patterned surface effects and producing marked changes in mechanical, textural, and utility values:—AVIATION, May, '45.

Continuous Cast Bronzes.....7

Now produced by continuous casting process in mill length rods are brass alloys stated to be previously available only as sand, permanent mold, or centrifugal castings. Process is described in Bulletin No. 131 from Ampco Metal, Milwaukee.—AVIATION May '45.

Motor Selector Guide.....8

Published to enable selection of correct type and size fractional hp. motor for any application, booklet from Dumore Co., Racine, Wis., gives characteristics of each type and tells how to decide on hp. and speed.—AVIATION, May, '45.

Aircraft Propellers 9

Operating principle of Iso-Rev aircraft propellers is fully described and illustrated in color booklet from Zimmer-Thomson Co., Long Island City, N. Y.—AVIATION, May, '45.

Lay-Out Plate 10

Circular from Contour Co., Pasadena, Calif., describes radial lay-out plate, use of which is stated to provide faster and more economical method of transferring information from blueprint or loft to master model, pattern, jig, or fixture.—AVIATION, May, '45.

Lubrication Performance.....11

Anti-Friction Bearing Manufacturers Assn., New York City, announces Technical Bulletins Nos. 4, 5, and 1 (limited number), covering tentative method for determination of performance characteristics of lubrication grease in anti-friction bearings at elevated temperatures.—AVIATION, May, '45.

Special Motors.....12

Catalog titled *Custom Built Motors for a World of Needs*, from Electrical Engineering & Mfg. Co., Los Angeles, lists and describes various types, including wing flap drive unit designed for Douglas A-26.—AVIATION, May, '45.

Progress Booklet 13

Thompson Products, Cleveland, has issued well-illustrated color booklet giving ten-year summary of progress, describing company products and policies, and looking into future.—AVIATION, May, '45.

Product Applications.....14

Goodyear Tire & Rubber Co., Akron, Ohio, offers manual in two parts, titled *Aviation Products*, designed to aid manufacturers in developing applications of products to fit specific needs. Vol. 1 covers tires, tubes, wheels, and brakes; and Vol. 2, fuel and oil cells, hose packing and seals, engine products, and other accessories. In *Aircraftsmanship*, another new booklet issued by company, are listed 53 major assemblies made by company for combat planes.—AVIATION, May, '45.

Aircraft Instruments.....15

Booklet from Kollsman Instrument Div., Square D Co., Elmhurst, N. Y., contains description of full line of aircraft instruments and details manufacturing procedures and tests.—AVIATION, May, '45.

Non-Ferrous Forgings.....16

Brass Forging Assn., New York City, announces Vol. 1, No. 1, of *Non-Ferrous Forgings Digest*, new publication of association.—AVIATION, May, '45.

Brake Intensifier 17

Circular from Pesco Products Co., Div. Borg-Warner Co., Cleveland, describes aircraft brake intensifier developed for use in medium sized aircraft where braking operation requires excessive effort. Unit, which weighs 5 lbs., may be installed anywhere between master cylinder and wheel brake.—AVIATION, May, '45.

MANUFACTURING DATA

Production Control.....18

McCaskey Register Co., Alliance, Ohio, offers circular concerning production system developed to provide central control, control within departments, check on payroll and costs, identification of parts moved, and other essential data.—AVIATION, May, '45.

AVIATION READER'S SERVICE — MAY 1945

AVIATION, 330 W. 42nd St., New York City 18

Please send me additional information according to key numbers circled.

INFORMATION TIPS:						1	2	3	4	5	6	7	8	9	10	11	12
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31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66
67	68	69	70	71	72	73											
NEW PRODUCTS:						74	75	76	77	78	79	80	81	82	83	84	85	86
87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
105	106	107	108	109	110												

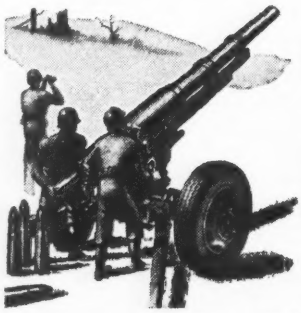
NAME..... TITLE.....

FIRM OR AFFILIATION.....

ADDRESS.....

HERE'S HOW Broaching by *American* helps

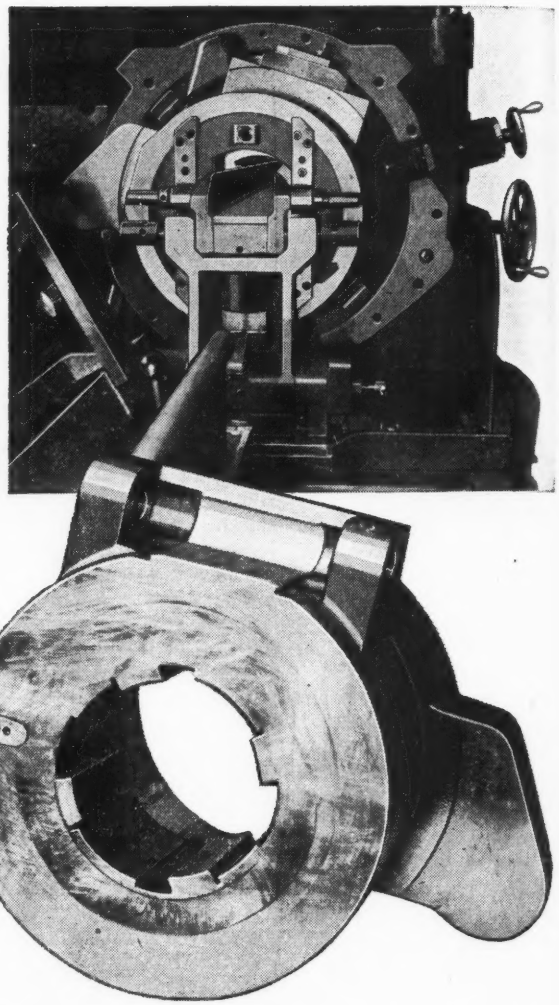
"KEEP UP THE BARRAGE"

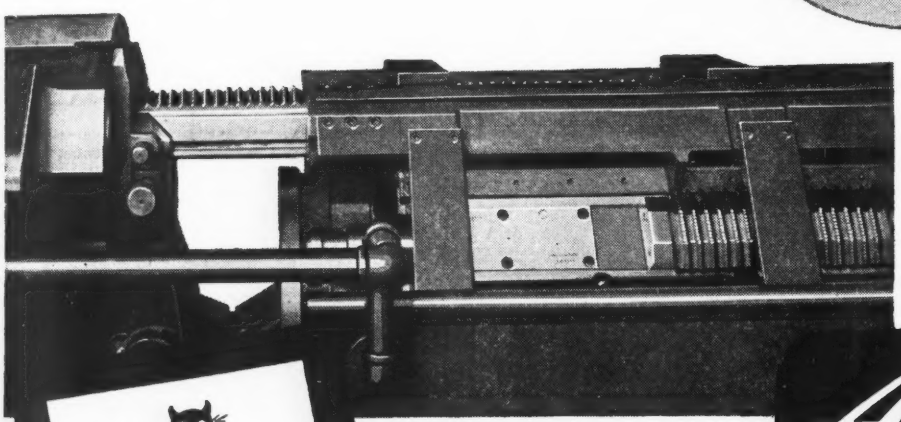


Speed — speed in production — is a prime factor in the manufacture of big guns to keep our far-flung battlefronts ablaze. "More guns in a hurry" has been a constant demand from all parts of the world.

A high rate of production—plus fine finish and absolute accuracy—has been attained by *American* engineers in designing equipment for broaching lock step slots in 8″ howitzer breech rings. The setup makes use of two *American* H-60-72 horizontal broaching machines and eleven different broaches to accomplish this task.

Whether your production requires fast output, excellent finish, or accuracy to close tolerances, whether it involves the use of standard or special machinery, let *American* engineers recommend the correct broaching equipment to do the job. *American's* complete broaching service—machines, tools, and engineering—is at your disposal. Write for details today.





Slots in breech rings for 8″ howitzers are broached on two *American* H-60-72 broaching machines, identical except for various broaches required for this operation. Top photo shows fixture which indexes the part one-quarter turn after each cut. Lower photo is of the finished part.

Above: American H-60-72 broaching machine, used in broaching lock step slots in 8″ howitzer breech rings. Turret holds five broaches and revolves after each four cuts to bring next broach in position for cutting. A similar set-up with six-broach revolving turret is used for completing the part.

MEMBER BROACHING TOOL INSTITUTE

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BROACH AND MACHINE CO.

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BROACHING MACHINES
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SPECIAL MACHINERY

DIVISION OF SUNDSTRAND MACHINE TOOL CO. ROCKFORD, ILLINOIS

Electrode Wall Chart.....19

New "Murex" wall chart issued by Metal & Thermit Corp., New York City, is 24x37 in. color piece listing electrodes in four groups: Mild steel, special steels, stainless steels, and hard surfacing, each being described according to AWS-ASTM class, color identification, recommended current strengths, polarity, and physical properties. —AVIATION, May, '45.

Welding Alloys.....20

Folder from Eutectic Welding Alloys Co., New York City, describes features of company's low temperature welding alloys and gives applications and specifications. —AVIATION, May, '45.

Export Packing.....21

Arrived O.K. is title of new booklet issued by Minnesota Mining & Mfg. Co., Minneapolis. Given is detailed information on adhesives, with illustrations of step-by-step operations involved in sealing packages.—AVIATION, May, '45.

Locking System.....22

New pamphlet from Bardwell & McAlister, Hollywood, Calif., illustrates applications of Rosan locking system for threaded inserts and studs.—AVIATION, May, '45.

Radium Paint.....23

Folder describing service of applying radium paint to aircraft instruments, is offered by Lustrolite Cleveland Corp., Cleveland.—AVIATION, May, '45.

Hard Facing.....24

Description of hard facing, its uses, and list of metals which can be hard faced, are contained in booklet from Mir-O-Col Alloy Co., Los Angeles. Also given is description of procedures, acetylene process, electric process, and information on company's welding rods.—AVIATION, May, '45.

Spring Lock Washers.....25

Double coil spring lock washers, stated to have exceptional reactive spring pressure, are described in folder from George K. Garrett Co., Philadelphia.—AVIATION, May, '45.

Rust Prevention.....26

Preliminary treatment of parts and machines before application of rust preventives and method of application, are discussed in *The Service Factor*, first edition 1945, issued by Sinclair Refining Co., New York City.—AVIATION, May, '45.

Parts Cleaning.....27

Description of machines and methods used in cleaning parts is contained in folder from Gray-Mills Co., Evanston, Ill. —AVIATION, May, '45.

Riveting Handbook.....28

Information on company's riveting process and detailed instructions on operation and care of tools is contained in handbook from Cherry Rivet Co., Los Angeles.—AVIATION, May, '45.

Grinders.....29

Bryant Chucking Grinder Co., Springfield, Vt., offers booklet describing various grinders made by company and illustrating operations on aircraft engine parts.— AVIATION, May, '45.

Induction Heating.....30

Containing history and description of induction heating, bulletin *Induction Heating and Melting in Industry* from Ajax Electrothermic Corp., Trenton, N. J., details various applications and includes numerous suggestions.—AVIATION, May, '45.

MACHINERY AND ACCESSORIES

Drilling-Boring-Facing Machine.....31

Circular from W. F. and John Barnes Co., Rockford, Ill., describes No. 924 vertical machine suitable for mass production drilling, boring, facing, and reaming operations that can be tooled to jobs requiring up to 60 hp. and 50,000 thrust. Illustrated are adaptations to several special operations.—AVIATION, May, '45.

Tubular Snap Gage.....32

Snap gage in tubular form described as having less expansion and less spring, with more sensitive feel and greater wearing qualities, is described in circular from Tubular Micrometer Co., St. James, Minn. —AVIATION, May, '45.

Inspecting Internal Surfaces.....33

"Borescopes" made by Polan Industries, Huntington, W. Va., designed for inspection of internal surfaces, such as parts and sections of aircraft engines, struts, and blind riveting, are described in circular. Instrument reveals cracks, tool marks, porous areas, slack pits, and other surface faults.—AVIATION, May, '45.

Safety Glassware Heater.....34

Bulletin HP-1650 from Precision Scientific Co., Chicago, describes line of safety heaters used for heating distillation columns, flasks, delicate reflux condensers, and other glassware.—AVIATION, May, '45.

Packings.....35

Publication *Packings Pointers No. 7*, from Graton & Knight Co., Worcester, Mass., contains information on adapter rings and leather vee packings. Additional circular describes various types of oil seals.—AVIATION, May, '45.

Collet Catalog.....36

Sheffer Collet Co., Traverse City, Mich., has issued new catalog on collets and stock pushers. Included is new "Super-Grip" collet which has cup point lug in each serrated section, designed to provide added holding power.—AVIATION, May, '45.

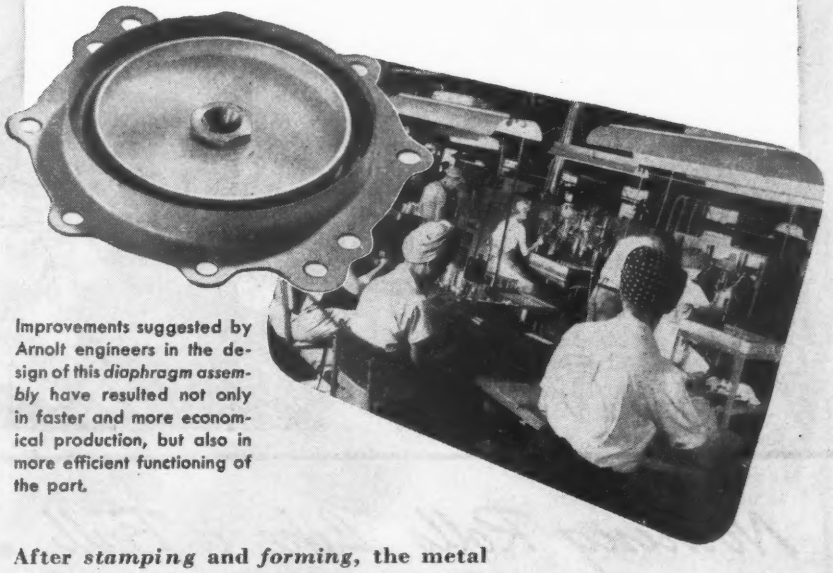
Belting Chart.....37

Issued by Baldwin Belting, Inc., New York City, chart provides reference for standard belt thicknesses and includes information on fastener and lacing sizes, Various types of transmission and conveyor belting are covered.—AVIATION, May, '45.

Tautness Meter.....38

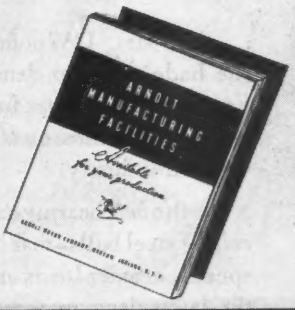
Instrument designed to measure tautness of doped fabrics in experimental

MANY ARNOLT FACILITIES WERE NEEDED FOR THIS JOB



Improvements suggested by Arnolt engineers in the design of this *diaphragm assembly* have resulted not only in faster and more economical production, but also in more efficient functioning of the part.

After *stamping* and *forming*, the metal shields of these diaphragm assemblies were machined by skilled Arnolt craftsmen. The center screw and lock nut also were made in Arnolt plants *on automatics*. The parts were then carefully assembled to most exacting specifications. This is one of hundreds of important tasks assigned to Arnolt. Why not let this well-equipped, trained organization help you with your production problems? Send for the new 16-page booklet describing Arnolt manufacturing facilities.



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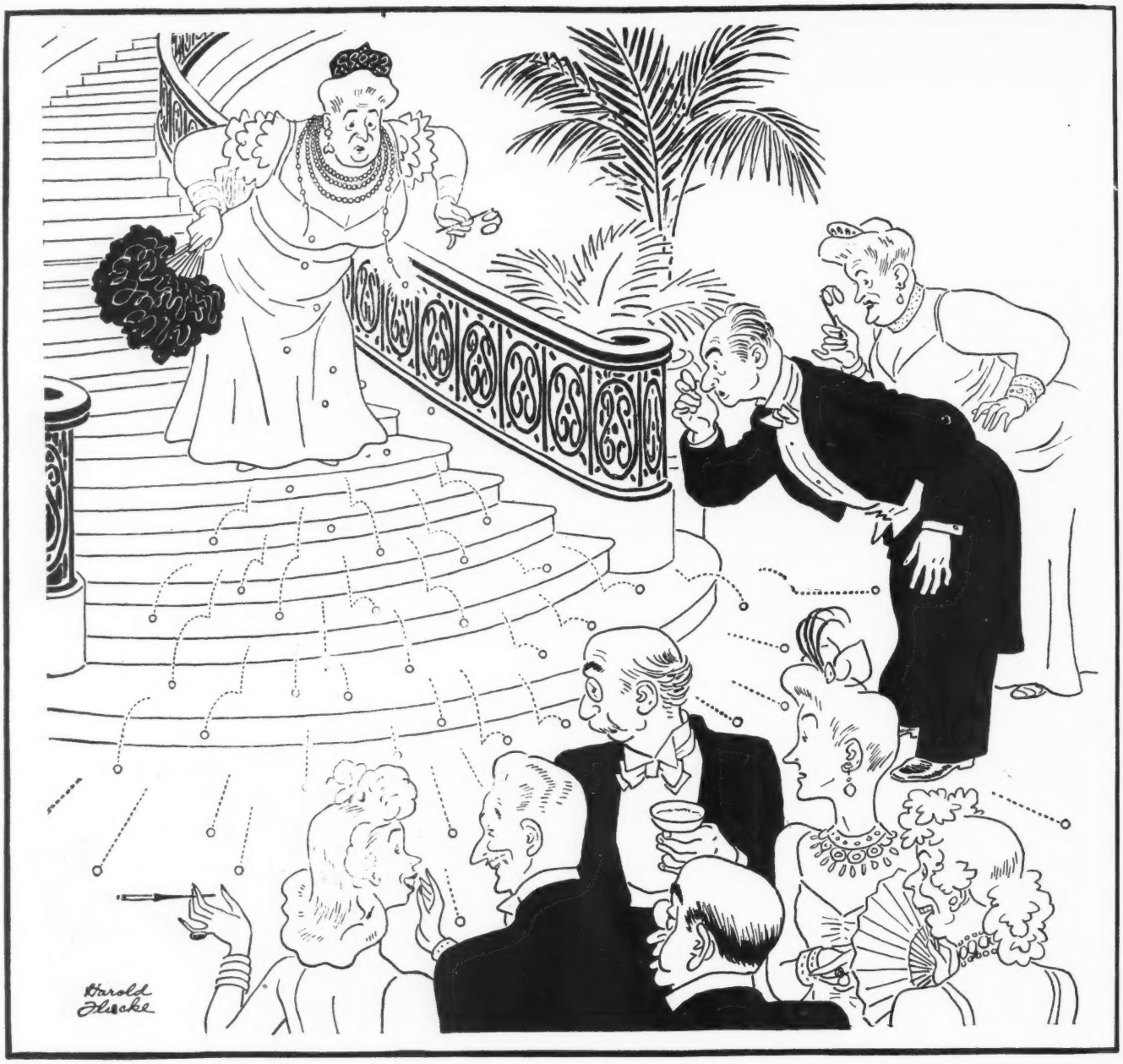

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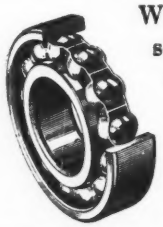
. . . but Mrs. J. Woofington Smith-Smythe wishes she hadn't had to demonstrate it in just that way. Especially since that fundamental fact *is* being demonstrated in *thousands* of ways in every phase of war and industry.

For the *ball* bearing carries the loads on *free-rolling* steel balls—making possible the higher speeds, heavier loads and rigidity essential to the latest developments in war and industry.



That is why over 300 million New Departure Ball Bearings are at work in this war. That is why designers of new and better machinery are designing more *ball* bearings into it than ever before.

We believe that nothing but the *ball* bearing has so many and varied advantages—in so many applications. Particularly when backed by the technical skill and experience that goes into New Departure Ball Bearings.

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BALL BEARINGS

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panels and in aircraft sections, is described in circular from Sherman W. Frazier, Washington, D. C.—AVIATION, May, '45.

Air-Operated Tools.....39

Essential information on representative models is offered maintenance men in booklet *Air-Operated Tools for Maintenance, Construction, Demolition,* issued by Ingersoll-Rand, Phillipsburg, N. J. Several new uses for well-known tools are shown. —AVIATION, May, '45.

Seam Welders.....40

Specifications, tooling data, and general information on Series PMM-1 180 kvm. seam welders, manufactured by Sciaky Bros., Chicago, are contained in Bulletin No. 113-A.—AVIATION, May, '45.

Press Brake 41

Having clear span of 20 ft. between housings and over-all die surface, or bending surface, of 30 ft., press brake made by Cincinnati Shaper Co., Cincinnati, Ohio, is described in Catalog B-2. Weighing 250,000 lb., huge machine has four main members—bed, ram, and two housings.—AVIATION, May, '45.

Hydraulic Press.....42

In publication No. 37, Hydraulic Press Mfg. Co., Mt. Gilead, Ohio, illustrates and describes press operations on superchargers.—AVIATION, May, '45.

Oil Power Transmissions.....43

Bulletin from Sundstrand Machine Tool Co., Rockford, Ill., titled *Sundstrand Oil Power Transmission for Variable Speeds.* describes operating principles, features, applications, and engineering data.—AVIATION, May, '45.

Carbide Tools.....44

Ludlum Steel Co., Brackenridge, Pa., has issued catalog on carbide blanks, carbide tipped tools, and AL tool shank steel in cold drawn bar.—AVIATION, May, '45.

Cleaning Equipment.....45

Used for cleaning, washing, paint stripping, rustproofing, chemical treatment, and coating, portable cleaning machines are described in Bulletin 4E2 titled *Batch Cleaning in Portable Metal Washing Machines for Production Maintenance and Repair.* Publication is issued by Optimus Equipment Co., Matawan, N. J.—AVIATION, May, '45.

Multi-V Belt Catalog.....46

Describing construction of multi-v and fractional hp. belts, new catalog sections from B. F. Goodrich Co., Akron, lists standard dimensions and interchangeability tables.—AVIATION, May, '45.

Spindle Machine.....47

Stated to be especially useful to pattern makers, spindle machine made by Kindt-Collins Co., Cleveland, is described in Bulletin No. B-3. Working with wood or soft metal, it is stated capable of making segments, tapered ribs, core prints, irregular shapes, templates, circular core boxes, and other parts.—AVIATION, May, '45.

Welding Equipment.....48

Imperial Brass Mfg. Co., Chicago, has issued Catalog No. 334-B, describing line of welding, cutting, brazing, and lead burning equipment.—AVIATION, May, '45.

Floor Machines.....49

Industrial floor machines used for restoration and maintenance of factory floors are described in folder from G. H. Tennant Co., Minneapolis, Minn.—AVIATION, May, '45.

Jig Catalog.....50

Describing operation and six new features of "Cone-Lok" jig, Catalog No. 45 J, from N. A. Woodworth Co., Detroit, contains data sheets and dimensional drawings.—AVIATION, May, '45.

Conveyors 51

Booklet issued by Standard Conveyor Co., No. St. Paul, Minn., titled *Standard Conveyors Do It Better, Faster, Easier, and Cheaper,* describes line of gravity and portable conveyors.—AVIATION, May, '45.

Gear Grinders.....52

For use in grinding external and internal cylindrical and conical surfaces, generated or formed spherical external and internal surfaces, and annular surfaces, such as ball bearing races and fillets, universal chucking grinder made by Gear Grinding Machine Co., Detroit, is described in folder.—AVIATION, May, '45.

Tension Control Backstand.....53

New circular describes combination in which backstand and contact wheel is connected to polishing lathe to provide belt grinder useful on many jobs. Tension is controlled by hand wheel and indicator is calibrated for exact duplication of tension, according to Divine Bros. Co., Utica, N. Y., which has issued full description of this set up of company-made units.—AVIATION, May, '45.

Cutting Machine.....54

"Zim" cutter, described in pamphlet from William-Leonard & Associates, Cleveland, is designed to cut any pliable material of width up to 1½ in. It consists of disk knife with handle, with mounting on plate and attachment to measuring device. —AVIATION, May, '45.

Gear Shaver.....55

National Broach & Machine Co., Detroit, has issued bulletin containing information on principle of cross-axle gear shaving. Included are illustrations of machines made by company.—AVIATION, May, '45.

Airblast Equipment.....56

Full line of airblast equipment, including rooms, cabinets, tanks, suction guns, nozzles, and accessories, are described in catalog from American Foundry Equipment Co., Mishawaka, Ind.—AVIATION, May, '45.

Variable Delivery Pumps.....57

Designed for applications requiring precise and rapid control of varying-volume, variable-delivery piston type pumps made by Vickers, Inc., Detroit, are described in circular. Typical applications are to presses of all kinds, machine tools and automatic machinery, rotary drives, and variable speed transmissions.—AVIATION, May, '45.

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GIVES YOU THE Finest ACCURACY in Stellite THREAD PLUG GAGES
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Blanks up to 1½" are cast Stellite—over 1½" are welded Stellite.
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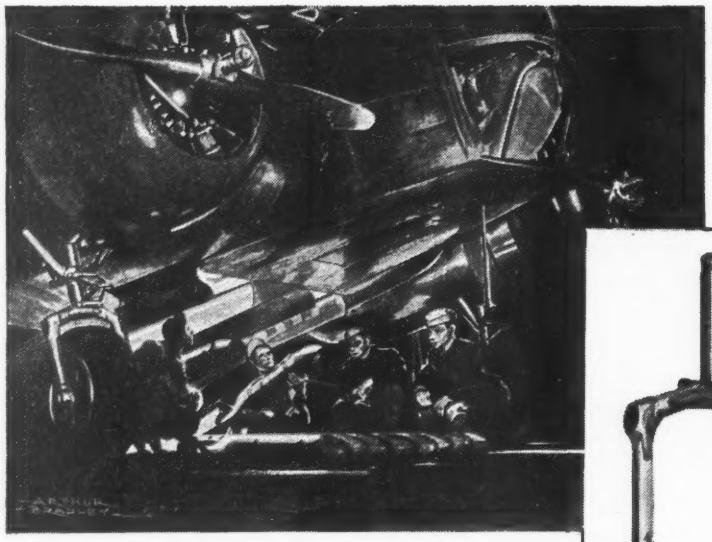

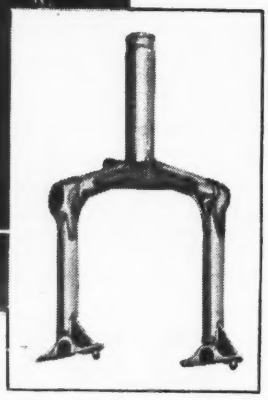

A BOMBER'S "FEET" DEPEND ON THIS FORK!

One of the highly essential precision items produced by the Welded Tubular Assembly Department of Aircraft Mechanics, Inc., is the "Beech Fork," used on many bombers serving our armed forces.

All tooling necessary for large quantity manufacture of the "Beech Fork" was produced in the Tool and Jig Departments of Aircraft Mechanics, Inc., — and schedules have been maintained as promised.

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ELECTRICAL

Test Equipment 58

High voltage test equipment, including portable kilovoltmeters, multipliers, and resistors for use with suitable meters, are described in Bulletin F from Shallcross Mfg. Co., Collingdale, Pa.—AVIATION, May, '45.

Fire Protection Equipment 59

Underwriters Laboratories, Chicago, has published 176-page booklet (issued semi-annually) listing inspected fire protection equipment and materials.—AVIATION, May, '45.

Resistors 60

Techtmann Industries, Milwaukee, has issued specifications folder concerning Regan resistors with glazed Steatite cores, single-unit and bank-type. Also covered are radiant heaters for temperatures to 1,700 deg. F.—AVIATION, May, '45.

Dialectric Capacitor Catalog 61

Described as complete guide to selection of dialectric capacitors, Catalog No. 20 from Sprague Electric Co., North Adams, Mass., contains full details and dimensions for all types.—AVIATION, May, '45.

Electronic Products 62

Condensed catalog covering tubes, oscillator plates, inspection units, diffraction equipment, and metallurgical products, has been issued by North American Phillips Co., New York City.—AVIATION, May, '45.

Instrument Tester 63

Aircraft Instrument tester, Model JK-6, made by Jordan Pump Co., Kansas City, Mo., is described in pamphlet. This portable instrument is designed to test all pressure instruments, gyroscopic instruments, temperature indicators, and tachometers. It is also suitable for other electrical tests.—AVIATION, May, '45.

Maintenance Equipment 64

Catalog from Weidenhoff, Inc., Chicago, describes line of aviation maintenance equipment applied in battery, electrical system, and magneto inspection. Comprising more than 50 pages, catalog is special color presentation giving accent to representative photos and explanatory diagrams of units and their components. Included is questionnaire querying operators on their present equipment and methods and inviting information regarding their needs.—AVIATION, May, '45.

Low-Volt Tester 65

Pocket size "Test Glo" low-voltage tester for circuits below 50v, is described in circular from the Ideal Commutator Dresser Co., Sycamore, Ill.—AVIATION, May, '45.

Ceramic Insulators 66

American Lava Corp., Chattanooga, Tenn., has issued Bulletin No. 444 containing illustrations of ceramic insulator bodies grouped by applications, such as for electrical, electronic, chemical, and other fields.—AVIATION, May, '45.

Industrial Electronics 67

Training material for use in teaching industrial electronics is offered by General Electric Co., Schenectady. Included are sound films, review booklets, and instructors guide.—AVIATION, May, '45.

STEELS

Hard-Facing Metal 68

"Fanweld", new hard-facing metal developed by Fansteel Metallurgical Corp., No. Chicago, is described in new booklet *When Production Races With the Clock* —AVIATION, May, '45.

Flat Ground Stock 69

Folder from Simonds Worden White Co., Dayton, Ohio, describes new non-deforming "Air-True" flat ground stock for use in precision tools, dies, jigs, and fixtures.—AVIATION, May, '45.

Boiler Tubes 70

Circular from Bissett Steel Co., Cleveland, lists sizes and specifications on boiler tubes of seamless steel.—AVIATION, May, '45.

MERCHANDISING

Aircraft Accessory Sales.....71

Scott Aviation Corp., Lancaster, N. Y., has issued booklet, *The Operation of Your Aircraft Accessory Business Now and Post-War*, containing information on sources of supply, inventory control, display methods, and other subjects.—AVIATION, May, '45.

MANAGEMENT AND EMPLOYEES

Influence of Colors.....72

Booklet *Color for Industry* from U. S. Gutta Percha Paint Co., Providence, R. I., manufacturer of "Barreled Sunlight", interior paint, discusses practical influence on workers of various colors, as regards safety factors, health, and efficiency.—AVIATION, May, '45.

Arc Welding Film.....73

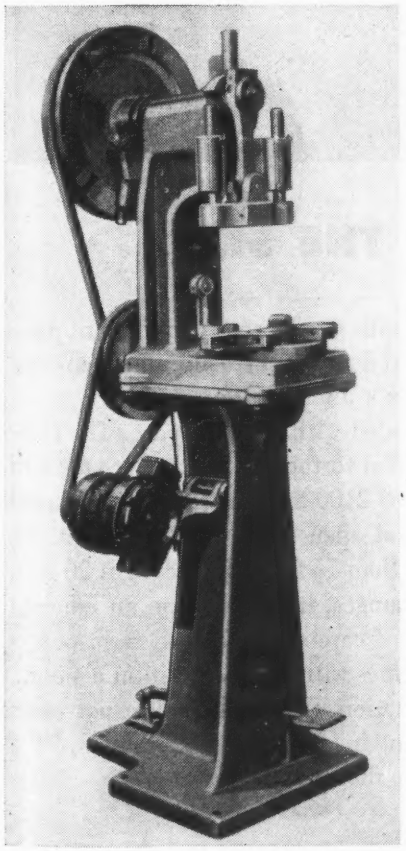
Progress of arc welding from its beginnings to its present role is shown in *Magic Wand of Industry—Arc Welding*, color motion picture released by Lincoln Electric Co., Cleveland.—AVIATION, May, '45.

NEW PRODUCTS

Latest Machine Tools

Punch Press.....74

Suitable for variety of small punch press work, new open face press made by **Maxant Button & Supply Co.**, Chicago, has large crosshead, ram adjustable for distance and rate of strokes, and automatic wick-oilers providing guide-rod lubrication. Throat height is 10 in., depth



4 in. Distance of bed slide is 7¼ in., while bed area is 9 x 8 in. Stroke is 2½ in. Stated to work equally well on metal, cloth, rubber, wood, synthetics, and plastics, press is recommended for such operations as stamping, perforating, blanking, punching, piercing, light drawing, forming and assembly jobs, crimping, and die work.—AVIATION, May, '45.

Forming Machine 75

Described as capable of properly and safely forming duraluminum, chrome molybdenum, rust resistant and spring tempered alloys, and other low ductile materials, forming machine known as radius brake is reported to eliminate fracture or disintegration at line of forming, and to obtain radii in accordance with predetermined standards. Case hardened and spring tempered materials that must be formed after heat treating can also be worked, maker states, and machine is adaptable for laboratory and research work. Radii obtainable with standard forming plates are: 0, 1/16, 3/32, ⅛, 5/32, and 3/16 in. Max. folding width is 12 in., max. full width folding cap. is 16 gage steel plate (heavier gages or narrower or more ductile materials in proportion), and max. deg. of angular folding is 110 deg. All contact surfaces are completely adjustable. Maker is **O'Neil-Irwin Mfg. Co.**, Minneapolis.—AVIATION, May, '45.

New Valve Improves Grinder.....76

Incorporation of new five-in-one hydraulic valve in surface grinders made by **Continental Machines**, Minneapolis, is described as affording increased speed, more

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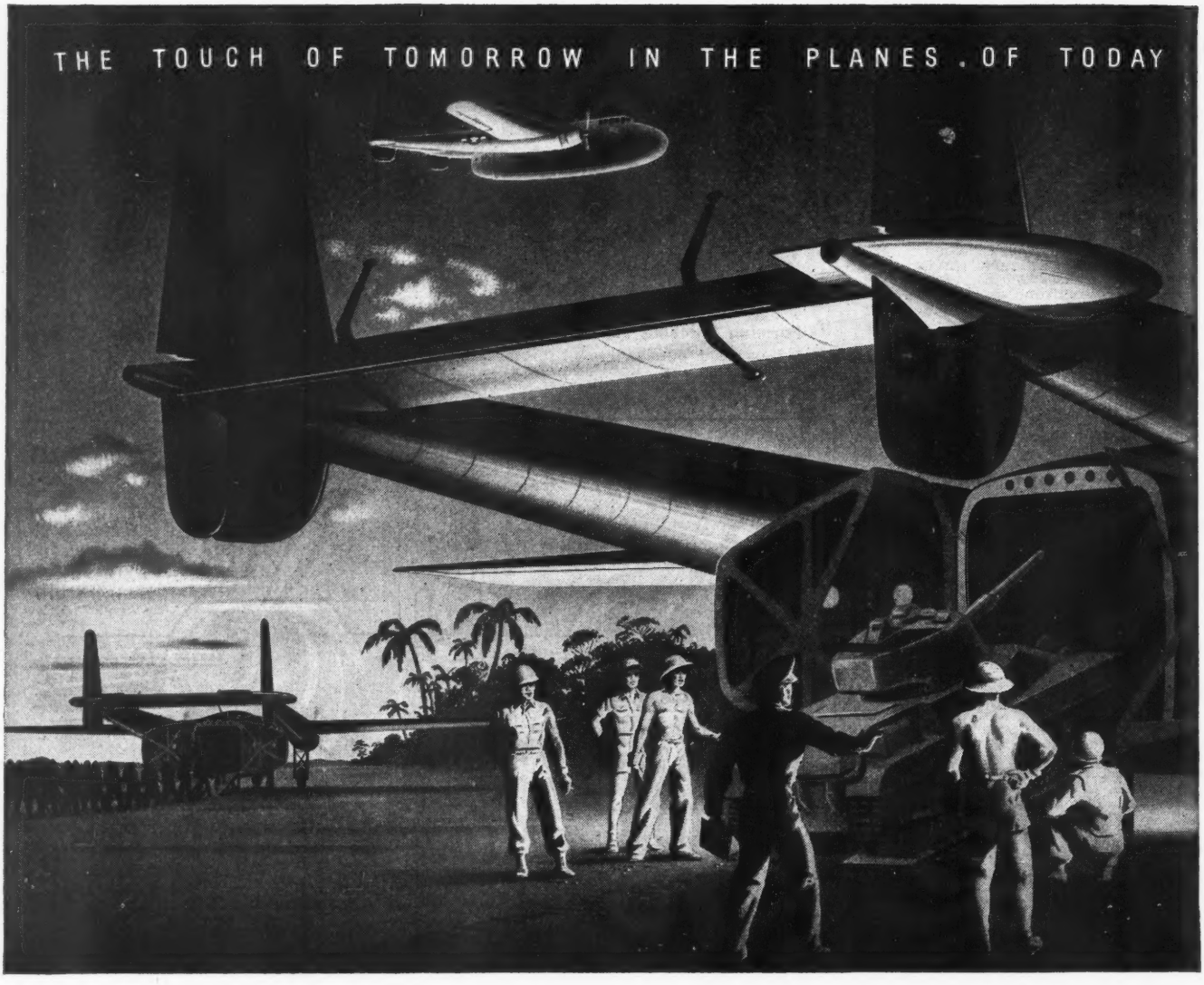

THERE ARE NO SIDETRACKS IN THE SKY

Cargo by the ton flies straight to its destination in the "Packet," the Army Air Forces' cargo carrier designed by Fairchild and built by Fairchild and North American Aviation.

Into the spacious hold of Fairchild's "Packet" will go lethal loads of guns, tanks, paratroopers, ammunition and supplies—destination Japan.

It is nicknamed the "flying boxcar" because of its cargo capacity—2,312 cubic feet of space—and its ability to carry up to nine tons at speeds which are still restricted information. Its maximum range, with conservative loads, is approximately 3,500 miles.

Forty-two paratroopers with full equipment can be "delivered" through two rear jump doors, clear of any obstruction. An ingenious device sends equipment parachuting through special doors in the belly, simultaneously with the paratrooper's jump.

The "Packet" is loaded with extreme ease. The floor of the fuselage is parallel to the ground and at standard truck floor height. Two 2100-horsepower engines impel its flight on wings that span more than 106 feet. Its overall length is more than 75 feet and its height 26 feet.

With but minor changes, it will become an efficient and profitable carrier of cargo and passengers in peacetime, flying the main lines with never a wait on a siding.

All metal in construction, this flying boxcar possesses characteristics inherent in all Fairchild products, "the touch of tomorrow in the planes of today."

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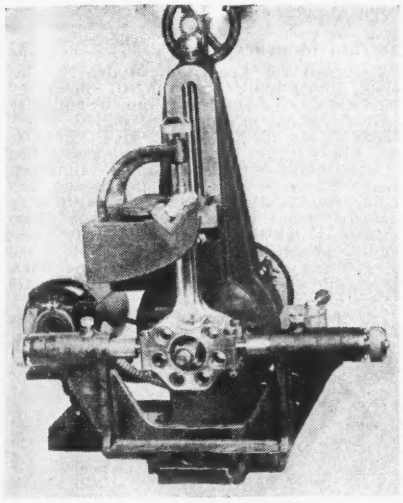
efficiency, simple operation, and accuracy, with operators permitted to give more attention to work piece without thinking of controls. Components are (1) table control valve for limiting table travel; (2) table reversing valve for table return; (3) selector valve having three positions—manual crossfeed, automatic crossfeed, and wheel dressing or rapid traverse; (4) crossfeed control; and (5) crossfeed directional valve which has neutral position for stopping carriage while in automatic position for locating work, and which also serves as limit stop.—AVIATION, May, '45.

Boring Machine 77

Developed for boring valves and gears, and for precision boring of connecting rods and many other items, "Hydro-Borer," Model A-3 has hydraulic feed system. Suitable for working bronze, babbitt, copper, and steel alloys, it bores

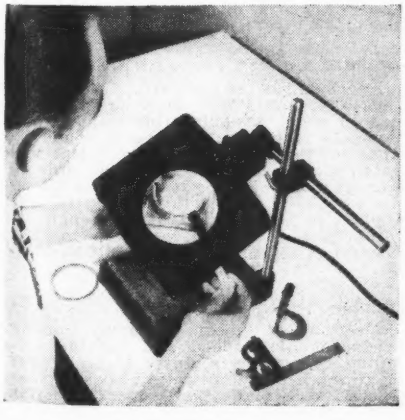


11/16 to 6 in. Traverse is 5¾ in. with 1¼ in. head and 2¾ in. with ¾ in. head. Feed is .004 in. and speed, 200-1000 rpm. (varying with pulley). Machine is equipped with: 2 in. offset boring head calibrated in thousandths, indicator and post assembly, 8 cutting tools, mandrels, 20-in. indexed-face plate, and adjustable holding fixtures. Maker is Hydro-Borer Div., Air-Parts, Inc., Glendale, Calif.—AVIATION, May, '45.

Shop Equipment & Materials

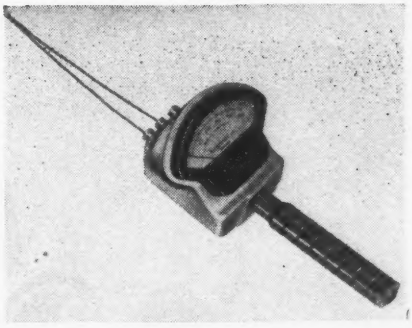
Illuminated All-Angle Magnifiers....78

Ullman Products Co., Brooklyn, N. Y., has added three new models of illuminated all-angle magnifiers to firm line, two of which are stand type and one a portable hand type. Lighting equipment of stand Model 410 and portable Model 610 consists of four incandescent tubes of which two or all can be used at one time. Two fluorescent tubes are used in stand Model 210. A 4½ in. double convex lens magnifies all objects twice up.—AVIATION, May, '45.



Self-Locking Drive Pins.....79

Available in broad variety of sizes, types, materials, and special designs, fully grooved self-locking pins made by Driv-Lok Pin Co., Chicago, now have pilot at one end so that pin can be more easily inserted. Pins have four flutes on surface parallel to axis, giving an expanded dia. a few (specified) thousandths greater than nominal dia. of pin. When pin is inserted in drilled hole, these raised edges are compressed inwardly, to provide a resilient, self-locking element which can be driven out and re-used.—AVIATION, May, '45.



Portable Pyrometer 80

Reported to be particularly adapted to reading temperature of molten metals (exclusive of ferrous metals), hot air, or liquids, and for hot surfaces, when used

Special aircraft alloys, NE alloys, Allegheny Stainless—literally thousands of kinds, shapes and sizes of steel are available on short notice from Ryerson stocks. Bars, plates, sheets, tubing, structurals are cut or otherwise prepared to exact specifications. Eleven plants—eleven stocks assure prompt delivery throughout the nation. Call Ryerson first, whatever your steel requirements, for effective cooperation.

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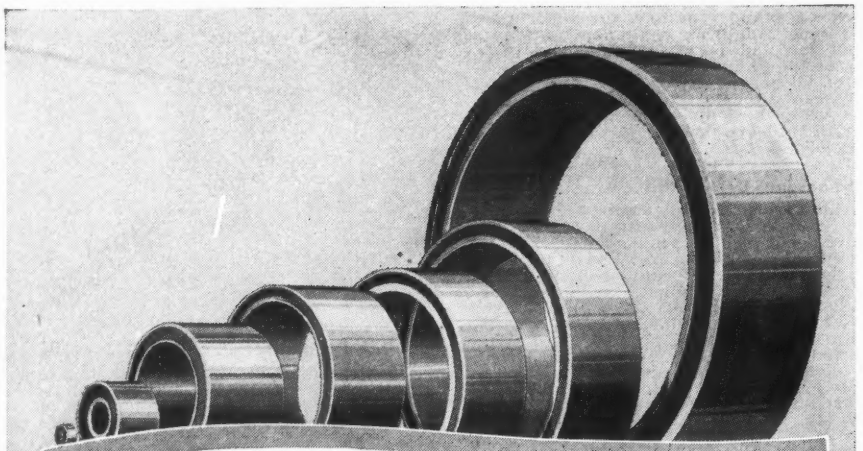

WIDE RANGE OF SIZES
Torflex FLEXIBLE BEARINGS

Torflex Bearings are not only unique in design and construction but they embody exclusive patented features which are more than just talking points.

Torflex Bearings consist of a seamless tube of rubber which has been stretched between two concentric metal tubes assuring high radial pressure which provides the required adhesion between the rubber and metal. Torflex Bearings take axial, torsional and radial loads. They absorb vibration, provide flexibility for cushion and misalignment, transmit torque, suppress noise, eliminate wear and friction and are being made in a wide range of sizes to carry loads from ounces to tons.

Harris Products Company pioneered in this field and for years, Torflex Bearings have been widely used in automobiles, tractors and industrial equipment. Today as in the prewar days, Torflex Bearings still lead, and are being used in combat tanks and for various types of war equipment. Our engineers over a period of years, have gained an enviable reputation in solving many difficult problems in connection with various types of equipment, by the application of Torflex Bearings thereto.

You may have some problem—current or postwar, that Torflex Bearings could solve better than anything else. Drop us a line and we'll be glad to work with you.

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CUSHIONS SHOCK...
STOPS VIBRATION

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Specialized Rubber Engineers and Sole Manufacturers of
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HARRIS COMPRESSED RUBBER BEARINGS

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PRODUCTS COMPANY
CLEVELAND 4, OHIO, U. S. A.

with prod-type thermocouple, portable pyrometer weighing 1¾ lb. has been developed by **K. H. Huppert Co.**, Chicago. Body design is described as elevating scale to angle offering max. reading ease, minimizing side reflections on scale glass, and reducing glass breakage. Duo scale is standard with readings of: 0 to 500 deg. F. and 0 to 1,000 deg. F.; 0 to 750 deg. F. and 0 to 1,500 deg. F.; or 0 to 1,000 deg. F. and 0 to 2,000 deg. F.—or equivalents in degrees C. Other scales are available. —**AVIATION, May, '45.**

Wet Belt Surfacer.....81

Line contact and grinding by wet belt method is now afforded on new machine, states maker, **Porter-Cable Machine Co.**, Syracuse, N. Y. Cool operation of unit is reported to speed cutting, prevent belt loading, and eliminate burring. Model WG-4 has 4 in. belt which works large area. Incorporated are 1½ hp. motor, self-contained recirculating system, and individual motorized pump.—**AVIATION, May, '45.**

Internal Measurer 82

Designed for precision, Model N-5 internal measuring instrument, made by **Sheffield Corp.**, Dayton, Ohio, is equipped with electrical gaging head called "Electrigage," an amplifying device (2,500 to 1). New type electrical magnification causes instantaneous action of indicator hand. There is stated to be no lag, and stylus has feather touch so that gaging pressure need never exceed 3 oz. Zero setting is obtained by use of adjustment knob, and automatic stabilizer is designed to prevent ordinary voltage variations. Range includes min. and max. dia. of .370

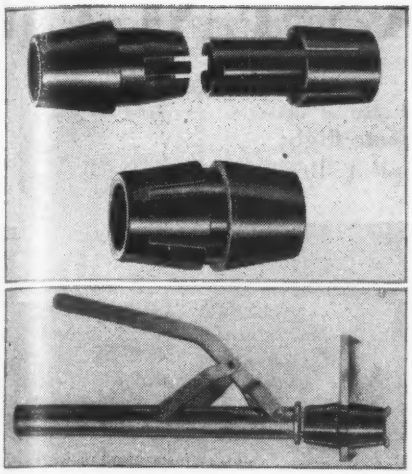
in. and 12 in., respectively. Surface plate is adjustable vertically, giving gaging from surface plate to center of diamond points of 1/16 in. to 1½ in. depth. It is possible to explore hole 3 in. deep for dia., taper, bell mouth, and out-of-round conditions. Capacity will accommodate an A.G.D. ring of largest size. Instrument can be supplied with special gaging arms for checking holes down to and including .240 in. dia. Max. gaging depth from surface plate to center of diamond points is 1 in. Linear scale is balanced type having total range of .0012 in. and distance between smallest graduations representing .00005 is approx. ⅛ in. so that interpolation to .000025 or less can be accomplished.—**AVIATION, May, '45.**

Sapphire Gages 83

Described as an important factor in precision manufacture because of resistance to wear, sapphire (hardest next to diamond) ring and plug gages made by **Sapphire Products Div., Elgin National Watch Co.**, Aurora, Ill., may be ordered to exact size needed, with no wear allowance required. Maker further states that sapphire is not affected by any chemical ordinarily encountered in gaging and is not subject to burring.—**AVIATION, May, '45.**

Machine Speed Calculator.....84

Selection of most efficient cutting speeds for high speed and carbide machining operations is stated to be simplified through use of new vest pocket plastic slide rule made by **Grove Calculator Co.**, Chicago.—**AVIATION, May, '45.**



Plastic Blind Grommet.....85

For many uses in electrical insulation, especially to insulate and protect lines passing through bulkheads of aircraft, new "Des-Grommet," a non-inflammable plastic blind grommet made by **Victory Mfg. Co.**, Pasadena, Calif., is composed of two parts so designed that they may be applied from one side by means of special tool. Tool with grommet is inserted in hole, then as grommet is drawn together, undercut section on one half is engaged with spring locking section on other, whereupon tool forces two sections together. Grommets are furnished in sizes to accommodate cables and tubes from ¼ through 2 in. dia. Two sizes for wall thicknesses, ⅛ to ½ in., and ½ to 1 in., are available. By addition of exterior pressure ring, installed over cable and locked into grommet, installation may be made pressure- and water-tight up to 25 lb. psi. Accompanying illustration shows grommet components (top), while special tool and grommet in place through wall are also depicted (bottom).—**AVIATION, May, '45.**

Salt Bath Furnace.....86

Long broaches and similar work may be heated in vertical position without distortion, it is stated, by means of new, large, internally heated salt bath furnace developed by **Upton Electric Furnace Co.**, Detroit. Depth of furnace is 81 in. and surface is 9 in. square, these proportions being obtainable through use of electrodes which enter through sides of furnace and at bottom of pot.—**AVIATION, May, '45.**

Skin Fastener Pliers 87

Pneumatically actuated, skin fastener pliers made by **Topflight Tool Co.**, Towson, Md., are described as easily operated

without fatigue, thus speeding up installation and removal of fasteners.—**AVIATION, May, '45.**

Tool Blank 88

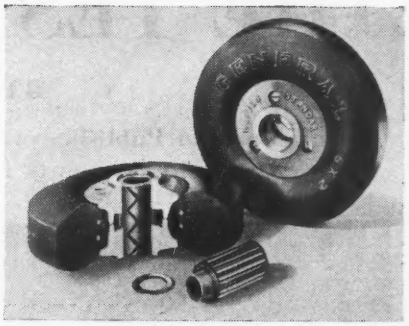
Now available from **Kennametal, Inc.**, Latrobe, Pa., is tool blank with drilled and counterbored hole for attachment to steel shank by means of recessed head cap screw. Rcesseds walls of shank take main cutting thrusts. With removal of tip, shank may be ground independently. Mechanical fastening is positive.—**AVIATION, May, '45.**

Parts Cleaner 89

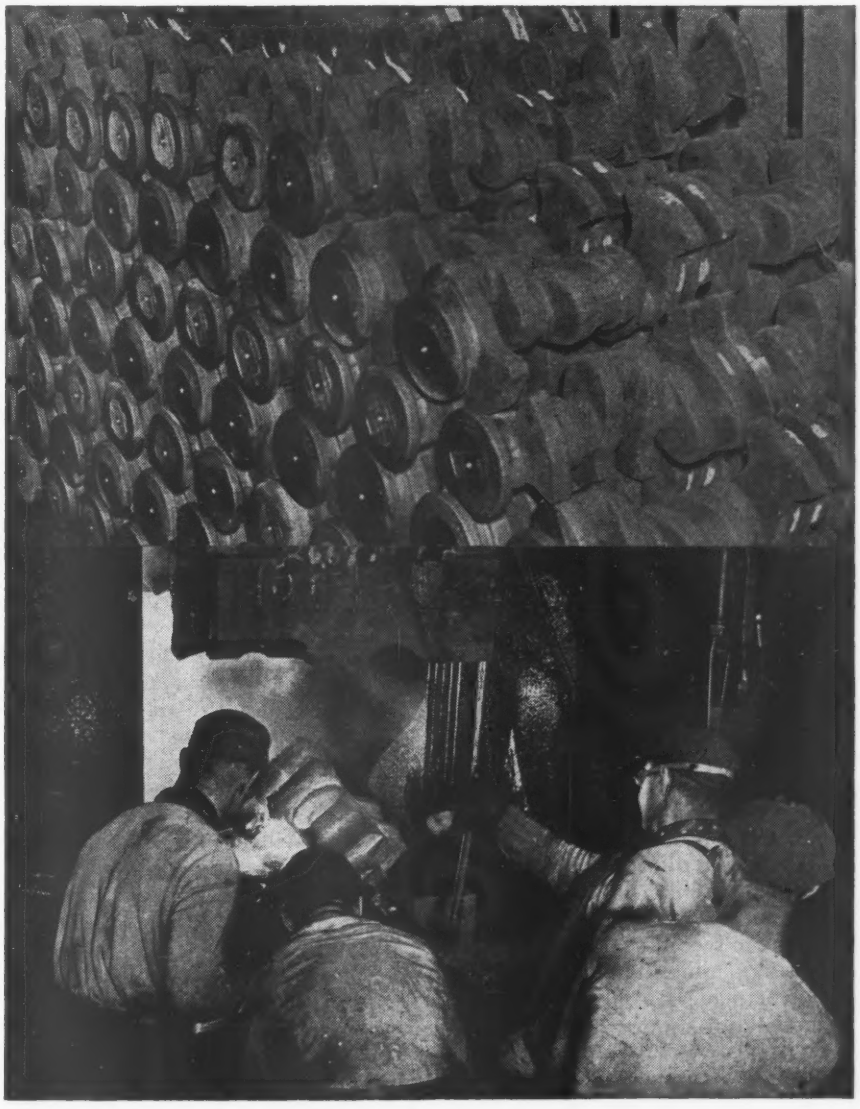
Incorporating safety fusible link and self-closing cover, electrically operated parts cleaner known as "Kleer-Flo 30," made by **Practical Products Co.**, Minneapolis, has 12 in. deep working space and will handle large or small parts, including electric motors, up to 300 lb. Tank requires max. of 20 gal. of compound, and included is soaking tank with 10 gal. additional cap.—**AVIATION, May, '45.**

Industrial Truck Air Wheel.....90

Designed for use on heavy duty materials-handling equipment, air wheel with demountable, cushion-type roller bearing rubber tires, is available in size 6 in. dia.



by 2.00 in. face, and in axle sizes of ¾, ⅞, and ½ in., with hub length of 2-3/16 in. Wheel has capacity of 250 lb. Maker is **Rapids-Standard Co.**, Grand Rapids, Mich.—**AVIATION, May, '45.**



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THE TEST PILOT'S PASSENGER

BY PHILLIP ANDREWS

Editor and Publisher of "Air News" and "Air Tech" tells how delicate flight research instruments run aircraft "behavior tests" while the pilot flies.

Test pilot Chalmers H. Goodlin and Engineer Stuart K. Edleson talk over a motion picture record of a test flight.

"ONE of the keenest scientific combinations of mechanical brains and eyes is the flight instrumentation equipment designed and built by Bell Aircraft's Flight Research Division. It is the kind of equipment which will assure safer flying for you in the peacetime aviation days to come.

"The test pilot of a high-performance fighter, like the Kingcobra, has no room for extra passengers, nor has he time to record scores of instrument readings himself. But the readings *must* be made—from all parts of the plane—and they must be complete and right.

"So Bell engineers developed their own equipment, smaller than available commercial instruments and capable of installation in half the time.

"From take-off to landing, while the pilot concentrates on putting the plane through her paces—loops, climbs, high-speed runs, breath-taking power dives—these delicate instruments are always at work, recording complicated data on stress, strain, pressure, temperature and all the other things the engineers want to know.

"While all this happens, a movie camera is automatically making a continuous film record, like the one shown in the picture, of all the cockpit panel instruments.

"And when the flying is done, the record is still there, accurate and complete, available for the kind of thorough analysis and study that makes for faster production in the factory and dependable planes in combat.

"Bell Aircraft's emphasis on scientific research and creative engineering has played an important part in the tremendous forward strides of the aircraft industry since the start of the war. And when the day of victory comes, count on this progressive company to pioneer on peacetime aviation horizons."

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ORDNANCE DIVISION
Burlington, Vt.
Flexible Gun Mounts and other ordnance materials

GEORGIA DIVISION
Marietta, Ga.
B-29 Boeing Designed Superfortress

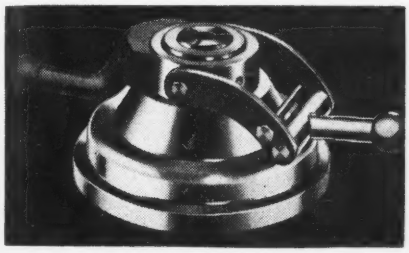
© Bell Aircraft Corporation

Flexible Shaft Angle Drills.....91

Including 18 and 30 in. flexible shafts coupled to 45, 90, or 360-deg. angle drills, full line of flexible shaft angle drills is available from **Zephyr Mfg. Co.**, Inglewood, Calif. Shafts alone can be supplied for coupling to other angle drills, or with threaded spindle for direct use.—**AVIATION, May, '45.**

Short Indexing Fixture.....92

Designed to eliminate complicated setups required to index work around 360 deg. of circle, short type indexing fixture, made by **Zagar Tool Co.**, Cleveland, uses only standard 5-C pull type collet and is



intended to go under small milling machines. Fixture will index any number of positions from 2 to 25 stations. Standard equipment includes 4-, 6-, and 8-div. index plates.—**AVIATION, May, '45.**

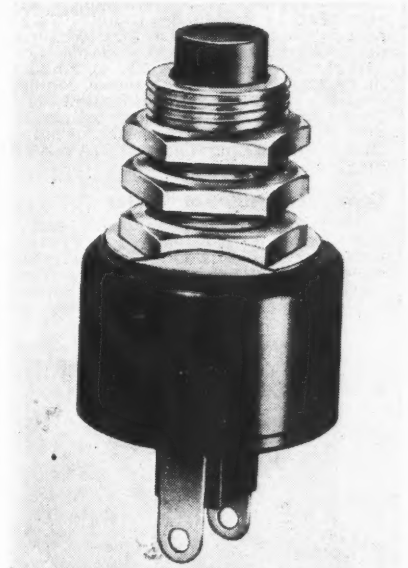
Lift Slings.....93

Macwhyte Co., Kenosha, Wis., announces addition to its line of "Level-Lift" slings, new capacities being ¾ and 1½ tons.—**AVIATION, May, '45.**

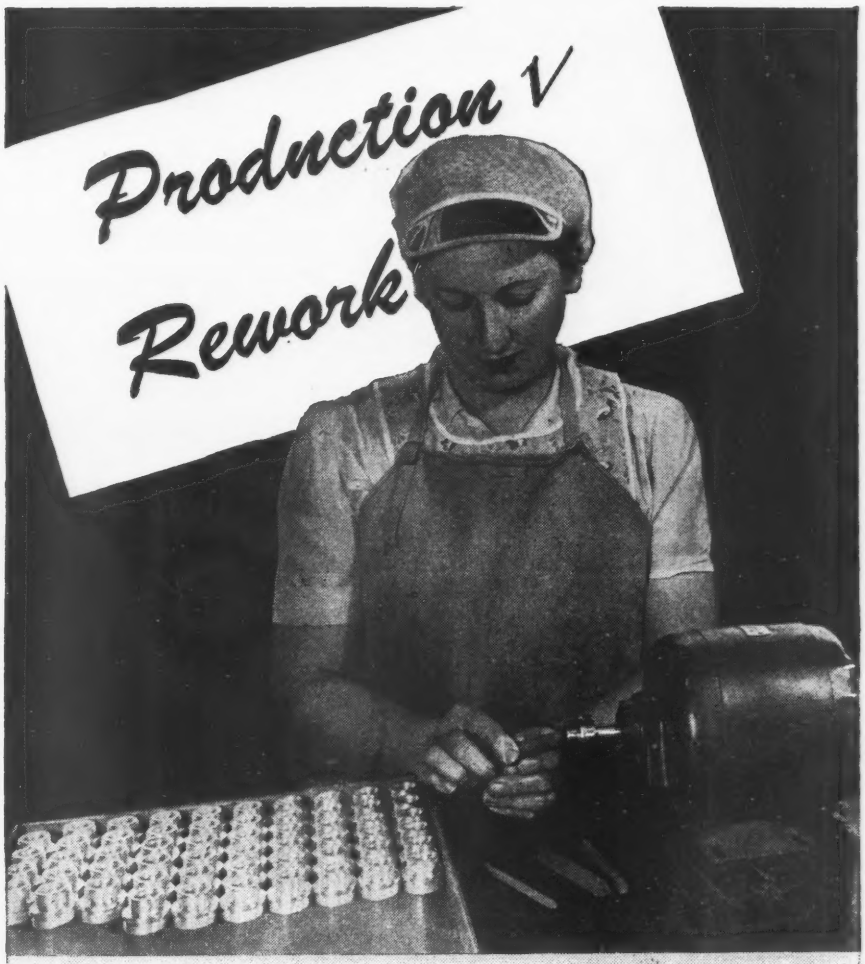
Electrical Appliances

Snap Action Switch.....94

Employing principle to assure fast make and break; as well as contact pressure of approx. 35 grams, making use practical on d.c., push-button switch has round phenolic body measuring ⅞ in. dia. by 1⅞ in. high. Switch is mounted by ⅝-32 bushing, 7/16 in. long and is held by two



mounting nuts. Contact gap is .040 in. on each contact, total gap breaking circuit being .080 in. Current rating is 10 amp. at 115v. a.c., and 2 amp. at 115v. d.c. Operation of switch produces decided "click" which is both heard and felt. Maker is **Grayhill Co.**, Chicago.—**AVIATION, May, '45.**



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Production deburring is simplified and speeded up with oilstone files. Precision parts rejected for scratches or burrs can be quickly reworked within tolerance, even after hardening, with these "all abrasive" files.

You'll find oilstone files are *all file*, not just a surface of tiny cut teeth. Continued use constantly exposes new cutting points. Abrasive files cut hardened parts just as easily as abrasive wheels cut hardened tool steels.

India (aluminum oxide, oil filled) and Hard Arkansas (natural abrasive) Files, offer you a complete size and shape range of over a hundred items from coarse, medium and fine India to the surgical fineness of Hard Arkansas.

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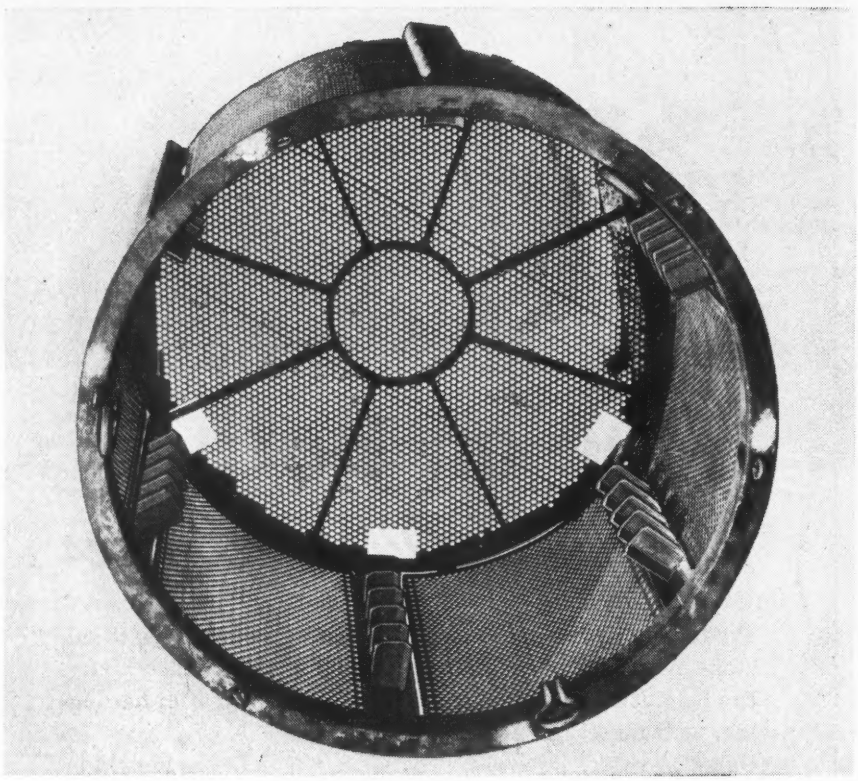

A special Annealing and Heat Treating Basket for general use in the aviation industry. Adjustable shelves and perforated to your specifications. Made in any size and style.

The Pressed Steel Company manufactures: **Carburizing and Annealing Boxes, Thermocouple Protection Tubes, Seamless Steel Cylinder Caps, Seamless Steel Neck Rings, Welded Alloy Tubing for High Temperature and Corrosive Application, Radient Tubes, Inner Covers and Base Sheaths for Steel Mills.**

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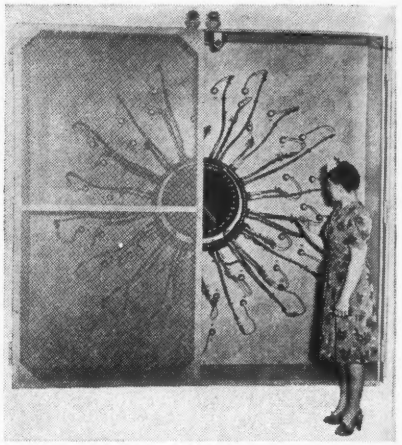
PRESSED STEEL COMPANY
WILKES-BARRE, PENNSYLVANIA

Ignition-Harness Tester 95

James L. Entwistle Co., Pawtucket, R. I., announces new device for production testing of aircraft engine harnesses. Manufacturer states that machine will test each lead individually against all others and the harness shield grounded, starting with zero voltage on each lead and increasing smoothly and automatically to specified test voltage, which is held for specified time interval. Voltage is then cut off and machine advances to next lead, where sequence starts again, cycle continuing until all leads have been high-potential tested. Next, machine is changed to sequence test, then advances from lead to lead, subjecting each to low-potential current test to determine continuity of copper and correctness of each connection between sparkplugs and magneto connector plugs. Lamp and buzzer announce



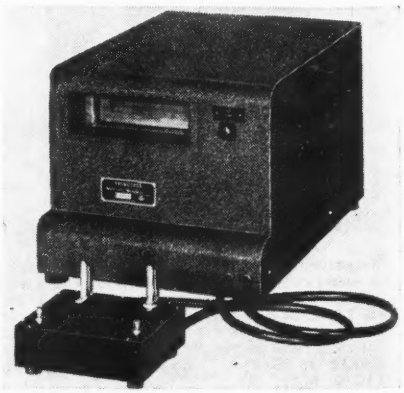
faults found in high-potential test, and arrow points to number of lead which has failed. Lamp and bell announce broken or incorrect connection during sequence test. All fault detection portions of circuit are in duplicate so that failure of any portion of such circuit cannot give false O.K. Max. test voltage is optional up to 50,000v., 60 cyc., or any other frequency. Length of time of voltage application is optional.—**AVIATION, May, '45.**

Resonance Meter 96

Described as meeting need for studying UHF phenomena and providing means of determining resonance and RF energy in oscillators and transmitters, tank circuits, atenna systems, coupling networks, and transmission lines, new resonance meter Type MW-70, has been developed by **Erco Radio Laboratories,** Hempstead, N. Y. Instrument is designed around a high Q concentric resonant chamber, center conductor of which is made variable through use of rack and spur gear. A small plug in pickup antenna is optimum coupled to center conductor. Rectification is obtained with a miniature crystal cartridge, and indication of resonance is directly shown on d.c. microameter.—**AVIATION, May, '45.**

Crankless Insulation Tester 97

Associated Research, Inc., Chicago, announces Model 238 "Vibrotest" crankless insulation resistance tester employing as indicating instrument spotlight galvanometer having 100 mm. scale calibrated 0-20,000 megohms direct reading, at a



potential of 500v. d.c. self-contained. Two No. 6 dry cells provide 500v. d.c. for operation through synchronous vibrator system. Galvanometer is permanently mounted within unit, readings being taken through shielded opening. Fixture at front is connected to instrument itself through insulated and guarded leads. Fixture may employ production-type connectors for connecting resistances or insulated products. One push button adjusts zero through set zero knob on front panel, another is for taking reading. Dimensions are 16 x 11 x 9 in., and weight is 24½ lb. —AVIATION, May, '45.

Regulated Voltage Power 98

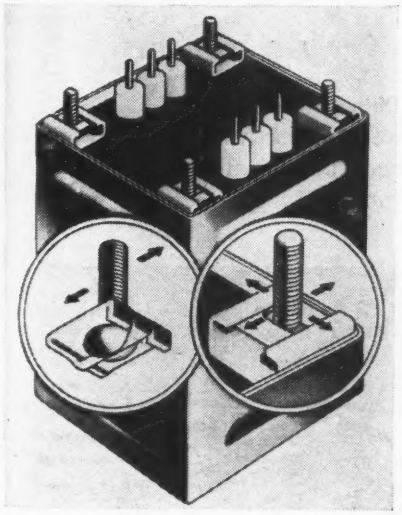
For testing aircraft instruments, inverters, controls, and radio navigational and communications equipment, also with suitability for other applications, **Federal Telephone & Radio Corp.**, Newark, N. J., has designed lightweight rectifier unit which closely regulates d.c. It operates from single phase a.c. 115v., 58 to 62 cyc., providing d.c. power up to 10 amp., continuous duty, at any selected voltage between 22 and 30v. Output is stated to be automatically held constant within plus or minus 0.5v. regardless of load variation or a.c. line voltage fluctuation of 105 to 125v. Ripple voltage is limited to approx. 5 percent. Equipment weighs 74 lb. and measures 11¼ x 8 x 16 in.—AVIATION, May, '45.

Magnetic Comparator 99

Redesigned, magnetic comparator manufactured by **General Electric Co.**, Schenectady, has new gray steel case with sloping front panel on which are located indicating instrument, variable-voltage transformer, and rheostats and switches. Graduated dial plates have been added on sensitivity and balance control rheostats to allow duplication of settings, and light is incorporated to indicate whether power is on or off. Connections for test fixtures are located at back of case.—AVIATION, May, '45.

High-Tolerance Transformers 100

Described as allowing tolerance in mounting dimension exceeding ¼ in. and as eliminating rejects due to bad threads, leaks around studs, bent or broken studs, or changes in length specifications, new transformers with self-aligning detachable mounting studs are offered by **Electronic Components Co.**, Los Angeles. A



simple clip arrangement of heavy stamped steel is designed to prevent stud from turning yet permits centering in two directions. Stud can be moved (not bent) in four directions, and it is replaceable with any round head machine screw.—AVIATION, May, '45.

Control Timer 101

One of the many applications of new control timer manufactured by **Reynolds Electric Co.**, Chicago, is to hydraulic press in which pressure valves are shut off on reaching certain tonnage, holding pressure for pre-determined time and signalling operator. Timer can also be equipped with interlocking controls so that each operation must be completed in correct sequence before next is started.—AVIATION, May, '45.

Portable Amplifier 102

Described as distortionless and humless, portable 30 watt amplifier operates on 110v. 60 cyc. a.c. and has two mike inputs and one phone input. Output impedances of 4, 6, 8, and 500 ohms may be selected. Frequency response is 50-10,000 cyc., record gain is 69 lb., and mike gain is 116 db. Tubes used are 3-6SJ7, 2-616, 6N7, and an 83. Cabinet measures 17 x 10½ x 19½ in. Maker is **Walker-Jimieson**, Chicago.—AVIATION, May, '45.

Rectifier Tube 103

Taylor Tubes, Inc., Chicago, has developed new high-vacuum half-wave rectifier tube 9⅞ in. high with max. dia. of 3-13/32 in. and designated TR-40M. It is equipped with four-pin jumbo (50w.) base and glass is Nonex. Filament is thoriated tungstein. Plate lead is at top, and filament leads are brought out to pins Nos. 2 and 4. Filament power is 5v. at 10.5 amp., and peak in forward volts is 25,000 while peak inverse volts is 60,000. Average plate current is 25 amp.—AVIATION, May, '45.

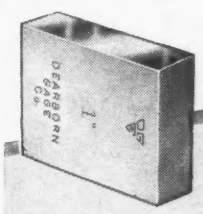
Aircraft Parts & Accessories

Cowl Mountings 104

Stated to be impervious to oil decomposition is new cowl mounting made of synthetic rubber by **Bushings, Inc.**, Berkley, Mich. Assembly of metal inner and outer shells is accomplished without vulcanizing, heightening resistance of mountings to heat.—AVIATION, May, '45.

Degreasing Unit 105

Stated to provide hot water-borne grease-emulsifying solution at high pressure and in ample volume to degrease, clean, and flush job in one operation, new unit made by **Hydra Lectric Products**



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PROMPT RETURN

Take advantage of Dearborn Gage Company's complete inspection service for all types of gage blocks. Just send your gages to us and they will be inspected immediately and returned to you within 10 days from the time received by us.

Accurate calibrations are made (after the removal of high spots or burrs) in our temperature controlled inspection room, at 68 degrees Fahrenheit.

Where gage blocks are not badly worn and a more complete calibration is required, end and center measurements are made on rectangular type gage blocks and at the center of each side of square blocks.

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2 types of inspection now available.

THE "W" (OR WORKING) CHECK:
Twenty five cents for each block smaller than one inch and twenty five cents for each additional inch or fraction thereof.

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Fifty cents for each block smaller than one inch.

Fifty cents per inch of block or fraction thereof of longer blocks.

REPLACEMENTS

When you send in your gage blocks for inspection it is very practical to give us specific instructions to replace any of your gages which we find to be worn beyond a certain tolerance. This specific tolerance is, of course, to be determined by you. You may also wish us to replace certain gages which have become damaged in some manner.

Reproduced above is a sample of a certificate of inspection, stating the specified size of each block measured and the actual measurement or variation from normal size.

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Phillips... has played a major part in "achieving the almost impossible"

Excerpt from the Report of the Special Sub-Committee on Petroleum Investigation, of the House of Representatives

January 2, 1945

"The United States has achieved the almost impossible by stepping up its daily production (of 100-octane fuel) from 45,000 barrels in December 1941 to more than 500,000 barrels. In the meantime, a remarkable improvement has been accomplished in the quality of the 100-octane product."

Phillips AVIATION GASOLINE

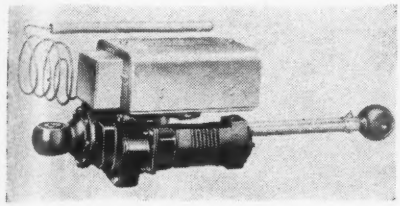
PHILLIPS PETROLEUM COMPANY, BARTLESVILLE, OKLAHOMA

A major supplier of 100 octane gasoline to the Army, Navy, and United Nations air forces

Corp., Indianapolis, is described as offering improved efficiency and economy in aircraft maintenance. Unit which is portable, delivers solution—hot or cold—at rate of 5 gal. per min. at 300 lb. nozzle pressure.—**AVIATION, May, '45.**

Linear Actuators 106

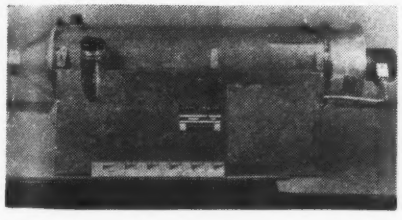
Designed to convert electrical energy into linear actuating force, Model 400 series of linear actuators, made by **Lear, Inc.**, Piqua, Ohio, features small size, weighs as little as 3.05 lb., and operates under loads up to 400 lb. of compression or tension. Requiring only 24-28v., Model



400 is less than 5 in. wide and less than 7 in. long. Extension length is from 1 4⅞ to almost 25 in. Control boxes are equipped with limit switch control of two, three, or more positions. "Fastop" clutch is designed to eliminate overtravel. Gear reduction ratios are available in various combinations, also position - indicating transmitters for visual check. Motor runs at average speeds of 9,000 to 11,000 rpm. in intermittent duty. Controls which respond automatically to changes in temperature are available, as well as immersion elements for use with air, oil, or glycol. Applications are to air filter doors, intercooler shutters, carburetor air duct shutters, trim tabs, dive flaps, oil cooler shutters, and glycol cooler shutters.—**AVIATION, May, '45.**

Portable Aircraft Heater.....107

Stated to be specially applicable for heating helicopters and hospital aircraft, and also for preheating engines, new portable "Janitrol" heater, manufactured by **Surface Combustion Co.**, Toledo, Ohio,



is completely self-contained except for motive power, weighs less than 38 lb., and has output of 40,000 btu. per hr. However, maker states unit more closely approaches 125,000 btu. in performance, since air is taken from cabin rather than from cold outer atmosphere. Thus unit is suitable for helicopters for no motion of aircraft is necessary for operation, from

ANNOUNCEMENTS—

of new machine tools, shop equipment and materials, electrical appliances, and aircraft parts and accessories are invited for inclusion in these columns.

In writing, emphasis upon specific aviation applications of newly-marketed items is desirable and whenever possible glossy-print photos should be enclosed. Please do not send electros. Manufacturers should address announcements to—

New Products Editor, AVIATION
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Heat, cold, solvent, and vibration resistant. Full line covering all requirements for high and low pressures, hydraulic and pneumatic.

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They've got a hot date in Tokyo—

Those B-29s are making a front-line battleground of the world's third largest city. Unmatched by the enemy in range, bomb-carrying capacity or altitude, the big ships now raining destruction on Japan symbolize American craftsmanship and fine American-made materials.

Important among those materials is aircraft wire for ignition, lighting and instruments. Made by Auto-Lite in one of its 22 great manufacturing plants, this wire is precision-built to perform above and beyond specifications.

Complete details covering the Low Tension wire are available in form 838. Form C-503A describes the famous 7 strand Steelductor High Tension wire used in fighting planes the world over. Write for your copies today.

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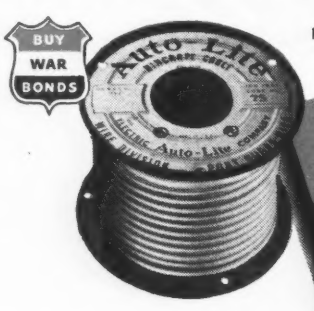
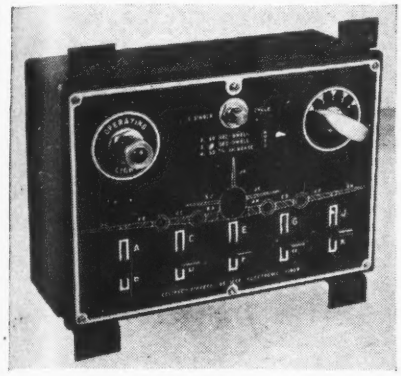


AUTO-LITE *Aircraft* **WIRE & CABLE**

ground level to its ceiling of 15,000 ft. Heater plugs into electrical connection, and fuel control switch gives high, medium, and low operation. A 3½ gal. fuel tank is built in to provide 8 hr. continuous operation of the heater.—**AVIATION, May, '45.**

De-Icer Timer 108

Electronic de-icer timer developed by **Eclipse-Pioneer Div., Bendix Aviation Corp.**, Teterboro, N. J., is for use with



manifold-solenoid system. Providing automatic or manual remote electrical control of boot operation, unit weighs but 6.5 lb. and measures 8¾ x 6-5/16 x 3¾ in.—**AVIATION, May, '45.**

Oil Filter 109

For filtering of lubricating oil while planes are in flight, **Hilliard Corp**, Elmira, N. Y., has developed "Flite-Filter," which is connected into pressure system of lubricating line where small portion of oil is metered off by bypass filtering. Another method is to install small rotary pump which takes oil from sump or hopper tank and forces it through filter. Filter is made of specially processed cellulose suitable for straight run mineral or heavy duty detergent type oils. Unit measures 7 x 17 in. and weighs 15 lb.—**AVIATION, May, '45.**

Carburetor Float Stand.....110

Designed to test float level and needle and seat of aircraft carburetors, Model A 501 carburetor float stand, manufactured by **Airplane Mfg. & Supply Corp.**, North Hollywood, Calif., has large hand pump

which gives pressure needed for flow of fuel. Pressure gage reads 0 to 15 lb. Stand measures 39 in. high, 24 in. wide, and 16 in. deep, and it weighs 80 lb.—**AVIATION, May, '45.**

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Conveyors and conveyor systems, adapted to your particular operations, speed up material and commodity handling activities, pull handling costs down to an economical level, speed the flow and movements of production. Conveyors handle a wide range of commodities — parts, packages, units, cartons, cans, bottles, barrels, bundles, drums, boxes. They are built in light, average, or heavy-duty types for either portable or stationary use—in a wide variety of sizes, styles and lengths.

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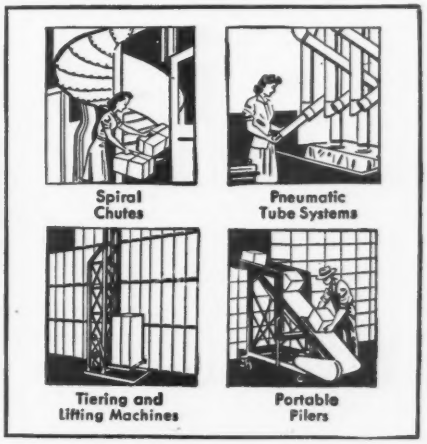

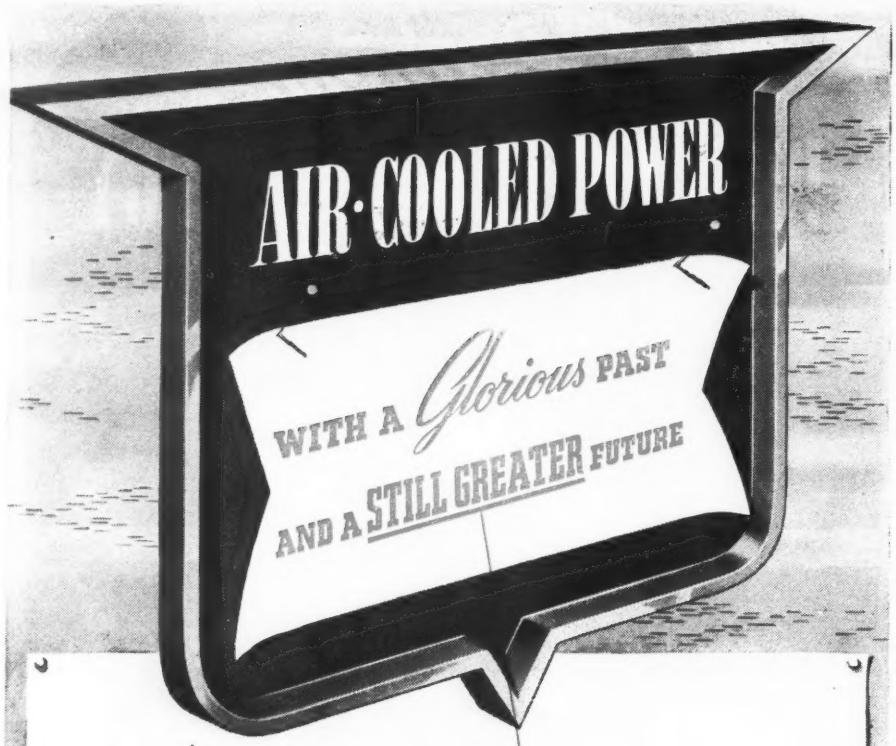

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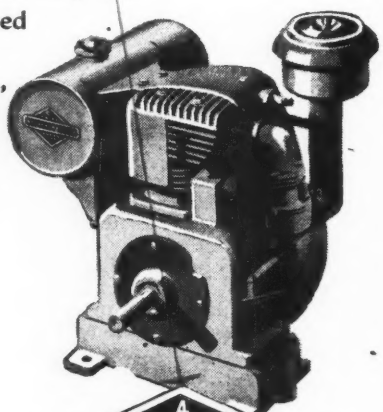

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BRIGGS & STRATTON CORP., Milwaukee 1, Wis., U. S. A.

ARMY E NAVY

Airplane Stability

(*Continued from Page* 155)

Now,

$$L = C_L \frac{\rho}{2} S (U^2 - 2Ury + y^2 r^2)$$

$$\therefore \Delta L = C_L \frac{\rho}{2} S (U^2 - 2Ury + y^2 r^2) - C_L \frac{\rho}{2} S U^2$$

$$= C_L \frac{\rho}{2} S (-2Ury + y^2 r^2)$$

$$= C_L \frac{\rho}{2} (c\,dy)(-2Ury + y^2 r^2)$$

Then,

$$\Delta L' = y \Delta L = C_L \frac{\rho}{2} c [-2Ury^2 + y^3 r^2]\,dy$$

$$\therefore L' = -C_L \frac{\rho}{2} c \times -\int_{-\frac{b}{2}}^{\frac{b}{2}} (-2Ury^2 + y^3 r^2)\,dy$$

$$= -C_L \frac{\rho}{2} c \left[-\frac{2Uy^3 r}{3} + \frac{y^4 r^2}{4} \right]_{-\frac{b}{2}}^{\frac{b}{2}}$$

$$= -C_L \frac{\rho}{2} c \left[-\frac{2Ub^3 r}{24} + \frac{b^4 r^2}{64} - \frac{2Ub^3 r}{24} - \frac{b^4 r^2}{64} \right]$$

$$= +\frac{C_L \rho c U b^3 r}{12}$$

$$\therefore \frac{dL'}{dr} = \frac{C_L \rho c U b^3}{12}$$

$$\therefore l_r = \frac{\frac{C_L \rho c U b^3}{12}}{\rho S V l^2 \xi} = \frac{C_L}{12 \xi} \left(\frac{b}{l} \right)^2$$

It will be noticed that this derivation applies to a rectangular wing only, since the value of $b \times c = S$, or wing area. The magnitude of l_r will be reduced when applied to tapered wings.

The last derivative we must handle to complete this study, is n_r. This is the damping in yaw, or the yawing moment due to yawing. It may be calculated, if the analysis is made separately for the wings and tail surfaces. Referring to Fig. 9 (a), we will handle the wing quantity first.

$$D = C_D \frac{\rho}{2} (U - yr)^2 c\,dy$$

$$= C_D \frac{\rho}{2} (U^2 - 2Ury + r^2 y^2) c\,dy$$

$$\therefore \Delta D = C_D \frac{\rho}{2} (U^2 - 2Ury + r^2 y^2) c\,dy - C_D \frac{\rho}{2} U^2 c\,dy$$

$$= C_D \frac{\rho}{2} (-2Ury + r^2 y^2) c\,dy$$

Then,

$$\Delta N = -y \times \Delta D$$

$$= -C_D \frac{\rho}{2} (-2Ury^2 + r^2 y^3) c\,dy$$

Then, integrating along the span for the yawing moment due to a change in drag, gives:

$$N = -C_D \frac{\rho}{2} c \int_{-\frac{b}{2}}^{\frac{b}{2}} (-2Ury^2 + r^2 y^3)\,dy$$

$$= -C_D \frac{\rho}{2} c \left[-\frac{2Ury^3}{3} + \frac{r^2 y^4}{4} \right]_{-\frac{b}{2}}^{\frac{b}{2}}$$

$$= -C_D \frac{\rho}{2} c \times$$

$$\left[\left(-\frac{2Urb^3}{24} + \frac{r^2 b^4}{64} \right) - \left(\frac{2Urb^3}{24} + \frac{r^2 b^4}{64} \right) \right]$$

Cancelling common terms,

$$\therefore N = -C_D \rho c \left[\frac{Urb^3}{12} \right]$$

$$\therefore n_r \text{ (wing only)} = -\frac{C_D}{12\zeta} \left(\frac{b}{l} \right)^2$$

Referring now to Fig. 9 (b), we shall derive the expression for the tail surfaces.

$$\Delta\psi = \arctan \frac{lr}{V} = \frac{lr}{V}$$

Then,

$$\Delta L_{VT} = \left(\frac{dC_L}{d\psi} \right)_{VT} \Delta\psi \frac{\rho}{2} V^2 S_T$$

$$\Delta N = -l \Delta L$$

$$= -l \left(\frac{dC_L}{d\psi} \right)_{VT} \frac{lr}{V} \frac{\rho}{2} V^2 S_T$$

$$= -\left(\frac{dC_L}{d\psi} \right)_{VT} \frac{l^2 r V S_T \rho}{2}$$

$$\therefore \frac{dN}{dr} = -\left(\frac{dC_L}{d\psi} \right)_{VT} \frac{l^2 V S_T \rho}{2}$$

$$\therefore n_r \text{ (tail only)} = -\left(\frac{dC_L}{d\psi} \right)_{VT} \frac{l^2 V S_T \rho}{2\rho S_w V l^2 \zeta}$$

$$= -\left(\frac{dC_L}{d\psi} \right)_{VT} \left(\frac{S_T}{S_w} \right) \frac{1}{2\zeta}$$

Therefore, by addition of the values for wing and tail, we get the total n_r:

$$n_r = -\frac{C_L b^2}{12\zeta l^2} - \left(\frac{dC_L}{d\psi} \right)_{VT} \left(\frac{S_T}{S_w} \right) \frac{1}{2\zeta}$$

As before, ζ is the radius of gyration.

In connection will all of the foregoing, there are a few general comments and precautions to offer: To keep the unit system homogeneous, all angles and slopes must be in radian measure. Values of C_L, C_D, and dC_L/α are all considered positive.

From basic aerodynamic theory, we know that,

$$C_L = 2\pi \sin \alpha$$

In actual practice, this expression is multiplied by a factor K.

Thus,

$$C_L = 2\pi \sin \alpha K$$

Since the angles of attack are small.

$$C_L = 2\pi \alpha_e K$$

and,

$$\alpha_e = \frac{C_L}{2\pi K}$$

$$\alpha_i = \frac{C_L}{\pi A}$$

where the former is the effective angle of attack, and the latter the induced angle of attack. Then, the geometric angle of attack is:

$$\alpha_g = \alpha_i + \alpha_e$$

$$= \frac{AC_L}{A2\pi K} + \frac{2C_L K}{2\pi A K}$$

where the value of A = aspect ratio.

In addition to the air loads and moments on the airplane, a completely precise analysis should include an analysis of the force which the gravitational field of the earth exerts through the center of gravity. The components of this force are found by multiplying the weight by the direction cosines along the vertical. Thus, if m is the mass of the airplane, and g the force of gravity, these components are:

$mg \sin \theta$ along OX
$mg \cos \theta \sin \phi$ along OY
$mg \cos \theta \cos \phi$ along OZ

Veteran Re-Employment

(*Continued from page* 107)

tical answer man" for a year, during which he underwent treatment. During rehabilitation his morale was bolstered by the fact that he was filling a place in the organization. He is now assigned to his prewar job, with entire satisfaction to himself and the company.

In routine jobs it takes approximately one full day to effect the employment of one man; some require several days. The personnel department has assigned rooms and interviewers to receive applicants, and a

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In the electronic age of tomorrow, the thorough shielding of electrical equipment of all types will be of even greater importance. To manufacturers or users of such equipment, Breeze engineering and production facilities make it America's Headquarters for Radio Ignition Shielding. For a complete analysis and recommendation, call in a Breeze Radio Shielding engineer.

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system of standard forms, questions, and procedures is used. Certain pre-employment tests serve as a rough guide in selection and placement. But each case must be handled on an individual basis. Very seldom are two people alike in all respects. The employee is a very important part of a business partnership and he must be treated as such.

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2. Acquire full understanding of present traffic control, changes in the airway to be flown, and any new aids to flight on the route.
3. Make three round trips on the run as first officer.
4. Take a standard company hood check and make at least three landings, one a single-engine approach and another by night, to qualify for day and night duty.

Men who have never served as captains with United, but who previously were qualified as first officers, will be assigned as first officers.

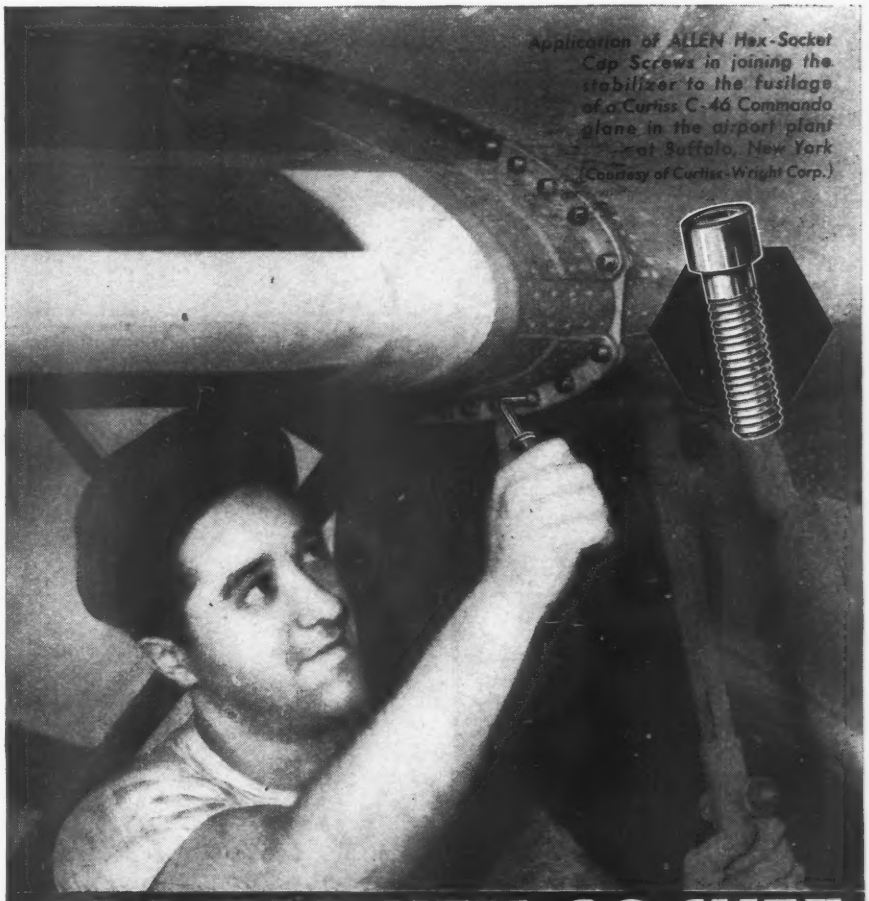
UAL was the first airline to announce a returning veterans' program. It is doing everything possible to make its work effective for the good of the country as a whole, for its own thousands of people, and for its own efficiency.

Those Gas Tax Dollars

(*Continued from page* 113)

tives to the state legislatures would recognize that the airplane is not tied to concrete pavement, that its speed and mobility defy state boundaries. And that, therefore, no individual state can justly set up a wall and say that when a flyer crosses its boundary he must start paying taxes on the fuel burned over that state.

Let us, then, plan a taxation and spending program for aviation, which is coherent and constructive. We


Application of ALLEN Hex-Socket Cap Screws in joining the stabilizer to the fusilage of a Curtiss C-46 Commando plane in the airport plant at Buffalo, New York
(Courtesy of Curtiss-Wright Corp.)

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ALLENS have strength for set-ups with weld-like grip, not to be budged by shock-stresses or sustained vibration. Thread tolerances are held to a high Class 3 fit, for a high degree of frictional holding-power... Screws cold-drawn and *"pressurformd"* of special-analysis ALLENOY steel, heat-treated under scientific controls. Hexagon sockets handily reached with Allen Hex Keys in the hardest-to-get-at places. Adapted to high-speed assembling with power drivers.

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might then specifically recommend—

1. That taxation of all aircraft gasoline be done by the federal government on a uniform basis all over the country.

2. That funds derived therefrom be allocated to the development of aviation, specifically for the building of landing facilities for the next ten years at least.

3. That the "property" classification of aircraft for tax purposes be changed. Let the states establish uniform registration fees, the funds thus collected to be sown back in aeronautical development as the state's contribution toward future aviation benefits.

4. That local communities also share in the cost of building landing facilities. They cannot expect the aircraft owners to bring the advantages to them and also foot the whole bill for it.

It will pay the nation's personal plane owners, as well as the commercial interests, to keep a weather eye on maneuvers of the state legislatures. During the last twelve years the nation's automobile drivers have paid $1,555,022,000 for highways that were never built. Diversion of automobile gasoline tax funds—enough to build eleven super arteries from New York to Los Angeles—has been a common artifice of state financial jugglers.

Unless we are on guard we can expect similar and continuing diversion of aviation gasoline tax revenues. For that reason we must insist on legislation making aviation gasoline free of state taxation. That money is too badly needed for continued aviation growth to allow it to be taken in 48 different guises and flung hither and yon with no concern for aviation needs.

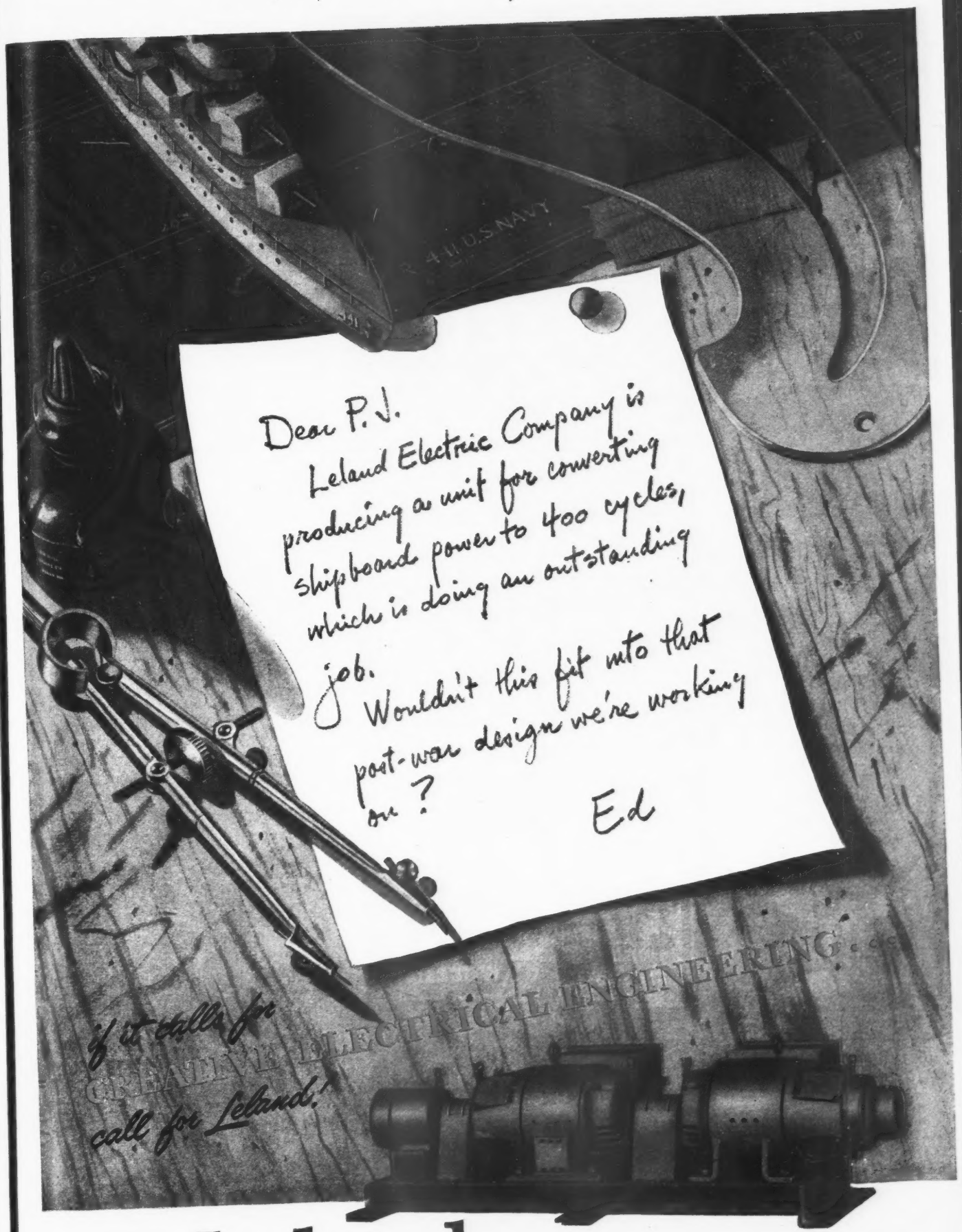
Industry's Finances

(*Continued from page* 117)

concerns. This is a larger amount than the unfilled orders of the entire industry one year after the European War broke out. Both Douglas and Lockheed officials were careful to point out that their commercial orders were conditional, depending on such things as delivery dates and prices.

On the matter of new products, if any, the 1944 reports made no startling revelations, although some of them went to considerable length to inform stockholders of ever-increasing research activities. On the other hand, the Packard Motor Co. report signified this organization's intention of remaining in the aircraft engine field after the war. Goodyear Tire & Rubber Co. also announced that it would continue its aircraft operations, but Firestone later reported it would withdraw from aircraft production.

Substantial progress was made last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year by the industry in preparing for contract terminations through establishment of special departments to handle terminations and by training men in all of the various intricacies of the problem.

Still overhanging the postwar prospects for the industry is the complicated problem of disposal of government-owned plants and facilities. But the more immediate 1945 problems will be cutbacks, cancellations, and sudden changes in production schedules. The experience the industry had in meeting these problems in 1944 will stand it in good stead when really large-scale cancellations and cutbacks begin to pour out of Washington, as they undoubtedly will later this year or in 1946.

Aircraft Research

(*Continued from page* 149)

2,993 ships. Only 95 fractures were potentially serious, while 6 resulted in the loss of the vessel. Many research projects are now underway to determine the relative importance of such factors as shrinkage stresses built into the hulls by the welding process, the behavior of steel at low temperatures, and the stress-strain characteristics inherent in the locally more rigid welded structure.

The serious nature of the Liberty ship problem taxes the metallurgical and welding experts of the National Bureau of Standards, the Bureau of Ships, the Armour Research Foundation, the War Metallurgy Committee, the University of California, the Illinois Institute of Technology, Lehigh University, and other technical institutions. Reduction in fractures in recent months may be credited jointly to the findings of the research committees of these institutions and to the speedy repair and reinforcement of all Liberty ships found needing structural changes.

In closing, it should again be stressed that it is very desirable in the arrangement of a research laboratory to avoid over-organization and "red tape". The men working in such laboratories are of a very independent and critical type of mind and are extremely impatient of bureaucratic methods. It is undoubtedly a great mistake to allow research work to be directed by administrators who have no real sympathy with the results of the work and who attempt continually to standardize and regulate things which, in themselves, are incapable of standardization and regulation.

No one can foretell the future of the present decentralized laboratories in the aircraft industry and of the ponderous centralized laboratories of

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Those Gas Tax Dollars

(*Continued from page* 113)

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2. That funds derived therefrom be allocated to the development of aviation, specifically for the building of landing facilities for the next ten years at least.

3. That the "property" classification of aircraft for tax purposes be changed. Let the states establish uniform registration fees, the funds thus collected to be sown back in aeronautical development as the state's contribution toward future aviation benefits.

4. That local communities also share in the cost of building landing facilities. They cannot expect the aircraft owners to bring the advantages to them and also foot the whole bill for it.

It will pay the nation's personal plane owners, as well as the commercial interests, to keep a weather eye on maneuvers of the state legislatures. During the last twelve years the nation's automobile drivers have paid $1,555,022,000 for highways that were never built. Diversion of automobile gasoline tax funds—enough to build eleven super arteries from New York to Los Angeles—has been a common artifice of state financial jugglers.

Unless we are on guard we can expect similar and continuing diversion of aviation gasoline tax revenues. For that reason we must insist on legislation making aviation gasoline free of state taxation. That money is too badly needed for continued aviation growth to allow it to be taken in 48 different guises and flung hither and yon with no concern for aviation needs.

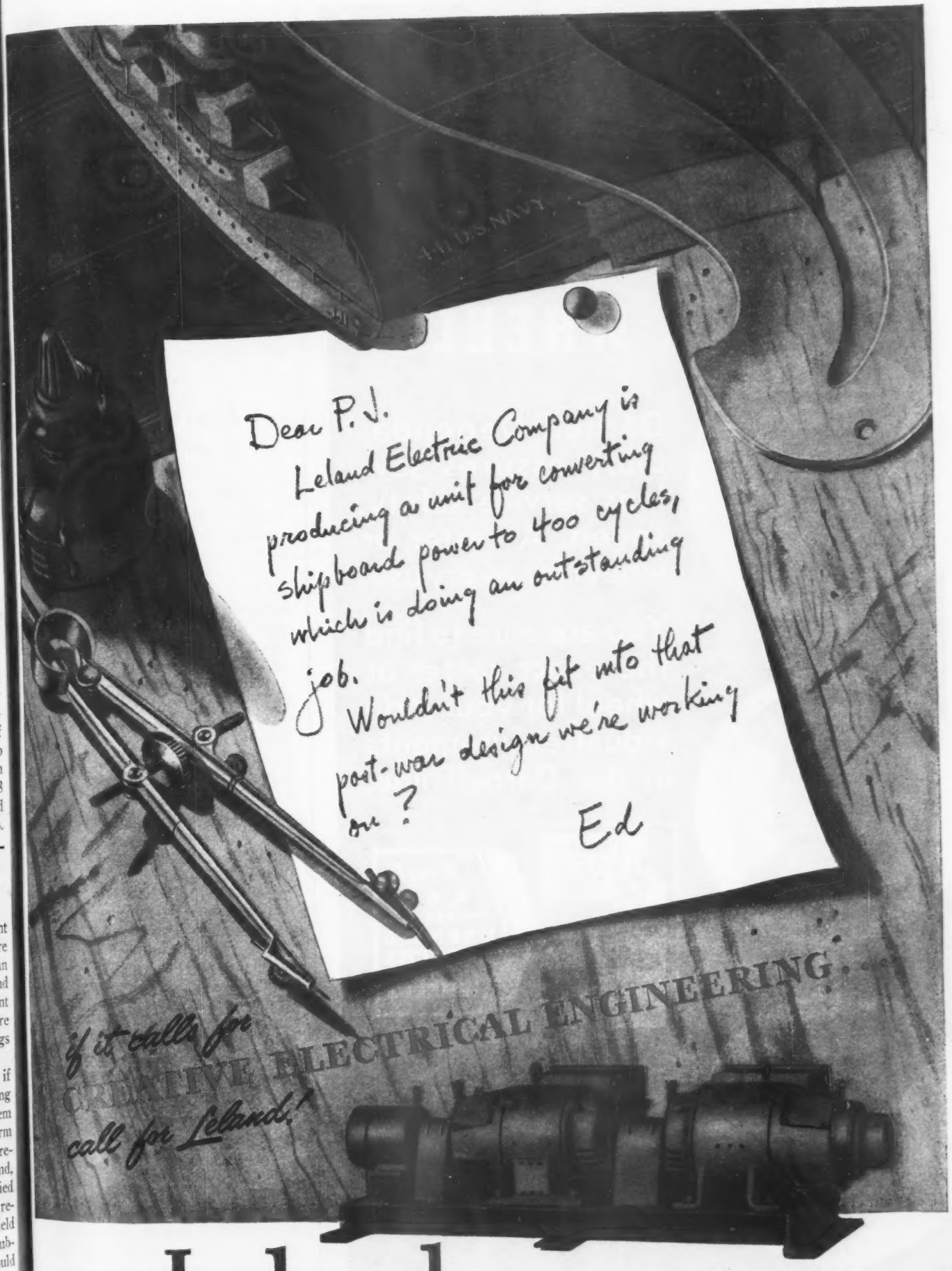
Industry's Finances

(*Continued from page* 117)

concerns. This is a larger amount than the unfilled orders of the entire industry one year after the European War broke out. Both Douglas and Lockheed officials were careful to point out that their commercial orders were conditional, depending on such things as delivery dates and prices.

On the matter of new products, if any, the 1944 reports made no startling revelations, although some of them went to considerable length to inform stockholders of ever-increasing research activities. On the other hand, the Packard Motor Co. report signified this organization's intention of remaining in the aircraft engine field after the war. Goodyear Tire & Rubber Co. also announced that it would continue its aircraft operations, but Firestone later reported it would withdraw from aircraft production.

Substantial progress was made last


Dear P. V.
Leland Electric Company is producing a unit for converting shipboard power to 400 cycles, which is doing an outstanding job.
Wouldn't this fit into that post-war design we're working on?
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CREATIVE ELECTRICAL ENGINEERING
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year by the industry in preparing for contract terminations through establishment of special departments to handle terminations and by training men in all of the various intricacies of the problem.

Still overhanging the postwar prospects for the industry is the complicated problem of disposal of government-owned plants and facilities. But the more immediate 1945 problems will be cutbacks, cancellations, and sudden changes in production schedules. The experience the industry had in meeting these problems in 1944 will stand it in good stead when really large-scale cancellations and cutbacks begin to pour out of Washington, as they undoubtedly will later this year or in 1946.

Aircraft Research

(*Continued from page* 149)

2,993 ships. Only 95 fractures were potentially serious, while 6 resulted in the loss of the vessel. Many research projects are now underway to determine the relative importance of such factors as shrinkage stresses built into the hulls by the welding process, the behavior of steel at low temperatures, and the stress-strain characteristics inherent in the locally more rigid welded structure.

The serious nature of the Liberty ship problem taxes the metallurgical and welding experts of the National Bureau of Standards, the Bureau of Ships, the Armour Research Foundation, the War Metallurgy Committee, the University of California, the Illinois Institute of Technology, Lehigh University, and other technical institutions. Reduction in fractures in recent months may be credited jointly to the findings of the research committees of these institutions and to the speedy repair and reinforcement of all Liberty ships found needing structural changes.

In closing, it should again be stressed that it is very desirable in the arrangement of a research laboratory to avoid over-organization and "red tape". The men working in such laboratories are of a very independent and critical type of mind and are extremely impatient of bureaucratic methods. It is undoubtedly a great mistake to allow research work to be directed by administrators who have no real sympathy with the results of the work and who attempt continually to standardize and regulate things which, in themselves, are incapable of standardization and regulation.

No one can foretell the future of the present decentralized laboratories in the aircraft industry and of the ponderous centralized laboratories of

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If you have a heat problem, South Wind engineers have several courses of action from which to choose. Your needs may call for exhaust gas heat exchangers or for one of the numerous flight-proved South Wind hermetic combustion heater models. Either way, you are assured of the finest heating engineering available today—*and tomorrow!*

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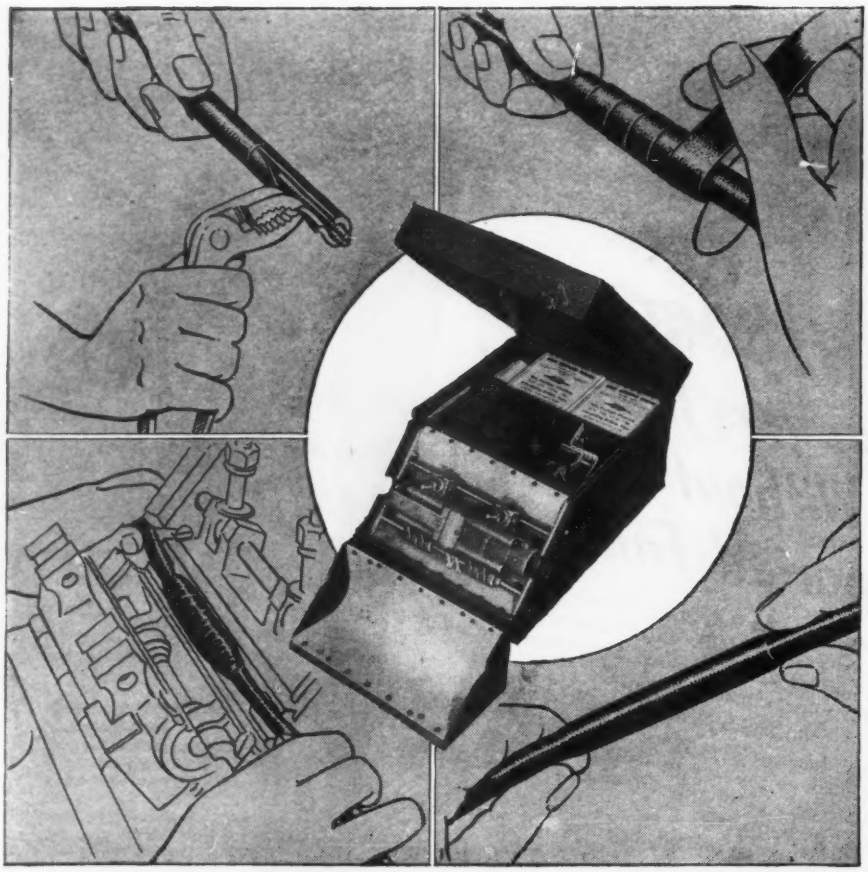

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This portable Kit Box contains all necessary supplies and tools. The Vulcanizer itself is mounted right into the Kit Box. Each unit is complete with heating elements, thermostatic controls, cable holding clamps, power input cord, wrenches, and an operating instruction manual.

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government agencies. Will the trend be toward more flexible centralization in the postwar years and thus follow the automotive industry history? Will the tendency be to make research subservient to engineering or to organize it to act as an impartial service and fact-finding department, under top management, for all departments and divisions? These are pertinent questions.

In next month's article (Part VI), the writer will initially discuss the financial problems of research institutions and then consider the construction of laboratory buildings and the various types of laboratory layouts to meet the differing needs of the aircraft industry.

References to Part V

Note: Articles once referenced in any part of this series will be referred to both by part number and by reference number, i.e., (II-6) indicates Part II, Reference 6.

(V-1) *Technical Laboratory*, Federal Bureau of Investigation, U. S. Dept. of Justice publication, 1942.

(V-2) *Wright Field and the American Future* by Edwin F. Dakin, *CVAC Plane Talk*, Nov. 1944.

(V-3) *Best by Test*, Naval Air Materiel Center *Air Scoop*, June 1944.

(V-4) *Patuxent River Naval Air Station—The Navy's New "Wright Field"* by E. M. Hockensmith, *Aero Digest*, July 1943.

(V-5) *National Bureau of Standards* by Lyman J. Briggs, Reprint from *The United States Dept. of Commerce: How It Serves You On Land and Sea and in the Air*, July 1941.

(V-6) *Coordination of Research and Testing Activities in the Aircraft Industry* by Maurice Nelles, OPRD, War Production Board, *The Welding Journal*, Sept. 1944.

(V-7) *Design and Methods of Construction of Welded Steel Merchant Vessels*, interim report given in *The Welding Journal*, Sept. 1944.

Book Reviews

(*Continued from page 202*)

materials of which they are constructed. Included are considerations of heat treatment of aluminum, welding, metal working, adhesives, sealing, plastics, and synthetic resins and rubbers. And special attention is given to the latest advances in the field.

AIRCRAFT VIBRATION AND FLUTTER, by C. R. Freberg and E. N. Kemler. Wiley & Sons, Ltd., New York-London. 214 pages, graphs, index. $3.00.
Explains the fundamentals and general phases of vibration and flutter affecting both stationary and rotating wing aircraft structures and their parts.

DICTIONARY OF ENGINEERING AND MACHINE SHOP TERMS, by A. H. Sandy. Chemical Publishing Co., N. Y. C. 153 pages, text. $2.75.
Handy compilation of important terms used in machine shops, in mechanical industries of all types, and in engineering literature.

THE AERONAUTICAL DICTIONARY, by Thomas A. Dickinson. Thomas Y. Crowell Co., N. Y. C. 484 pages. $3.00.
Over 6,000 aeronautical terms defined with more than 300 drawings and photos included to illustrate meanings of difficult or obscure words. Work relates to every phase of aviation, including aerodynamics, meteorology, avigation, piloting, engineering, metallurgy, design, loftings, and construction.

THE MODERN GAS TURBINE, by Tom Sawyer. Prentice-Hall, N. Y. C. 216 pages, text, drawings, graphs, appendix, index. $4.00.
Thorough discussion of the gas turbine with pertinent sections on its supercharger and prime mover uses, including jet propulsion, with detailed data on the aeronautical, marine, railway, and indus-

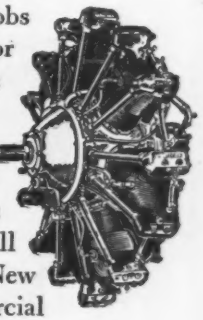
Once the doughfoot envied the airman's easier life and extra pay—and "he rides to work"... but today he knows the comfort of a curtain of planes, and that the business-bent bombers passing overhead mean fewer bullets he may have to stop.

At home, however, too few people realize that the busy bombers have been life insurance for the ground troops... The Air Forces cost Germany factories, munitions, morale, tied down an estimated million troops in the Reich before D-day... kept ships and supplies from reaching Rommel in the last six weeks of the Tunisian campaign... softened up Italy... broke up Nazi communications and supply lines in France, and actually kept reinforcements from arriving!

In the Pacific, American air power sank one Jap fleet in the Bismarck Sea, starved Jap bases, helped seal off New Guinea, Truk, Yap, Palau, made every island landing easier. How much worse Tarawa and Iwo Jima might have been, had no air attacks preceded the Marines!... And now the Super-forts risk three thousand mile missions over water—to save lives on the day our landing craft grate on the beaches of Japan.

To date, the Air Forces have lost about *ten thousand bombers*—but every plane and airman lost has saved two, ten, or a hundred lives on the ground! Be glad we had so many—and grateful to the men who sacrificed themselves to make the bombers worth so much!

BACK of the bomber records was the bomber training program—and the Jacobs engine, used in the twin-engine trainers in which bomber pilots were schooled... Subject to the hardest service of any engine, the Jacobs ran up its service period between major overhauls from 350 to as much as 1,200 flight hours, set new records for maintenance and low costs... saved money for American taxpayers.



And the more than 30,000 engines Jacobs has made during this war will make Jacobs' postwar engines better! New models are forthcoming for commercial operation and for light planes—with the same old Jacobs stamina and service! Jacobs Aircraft Engine Company, Pottstown, Pennsylvania.

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trial applications. A bibliography is included.

QUALITY CONTROL WITH DOALL GAGES AND GAGE INSTRUMENT, Doall Continental Machines, Inc., Minn. 141 pages, text, photos, glossary.
Consideration in handbook form of scientific inspection, with use of over 200 photographs, diagrams, charts, and tables.

GOVERNMENT POLICY TOWARD COMMERCIAL AVIATION, by Gilbert Goodman. King's Crown Press, N. Y. C. 122 pages, text, index. $1.60.
Scholarly study of the subject of government policy with respect to scheduled air transportation in the phases of competition and regulation of mail rates. Included are sections on foreign air transportation and mail rates.

FLIGHT HANDBOOK, "Flight" and "Aircraft Engineer," England. 212 pages, text, photos, graphs, advertiser's index. 7/10 (about $2.25).
Condensation of material in the official organ of the Royal Aero Club bearing upon the theory and practice of the broad field of aeronautics. The work is well illustrated.

AIR POWER FOR PEACE, by Eugene E. Wilson. McGraw-Hill Book Co., N. Y. C. 182 pages, illustrations, appendix. $2.00.
Initial step toward analyzing air power as Mahan did sea power, this is the first sound evaluation of a new force and its impact on world security, developing the concept that civil aviation and aircraft production are essential components of the forces required to maintain peace as well as sources of employment. Backed by reviews of major military actions in the light of this concept, it puts forward a sound national policy which shows clearly the importance to our peace and prosperity of maintaining America's top position in air power. (Two chapters from this work appeared in January and February AVIATION as a two-part article titled "Air Power—The Key to Peace and Prosperity.")

AIRCRAFT ARMAMENT, by Louis Brouchiss, Aerosphere, Inc., N. Y. C. 224 pages, photos, drawings, glossary, index. $6.00.
Thorough review of the complex phases of the armament and armor, defensive and offensive, of military aircraft. Well laid out, the volume treats first of the early history of plane armaments, then proceeds to the subjects of aircraft bombs, aircraft machine guns, aircraft cannon, ammunition, and turrets. Next, foreign aircraft weapons are considered, then the work continues with the topics of armor protection, anti-aircraft weapons, gunnery training, self-propelled ammunition and bombs, and finally there is a stimulating section on future aircraft weapons and air warfare. Mr. Brouchiss has here written a pertinent, definitive work, and his illustrations, comprising both photographs and drawings, are well-detailed. The textbook quality of this volume marks it as a work of particular interest to armament men, aircraft producers, and to aviation writers and editors.

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Phantom drawing by David T. Hoel

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Note the Northrop-designed retractable ailerons (shown raised on top of plane's wing), which make possible fast, tight turns, and leave the trailing edge free for full-span wing flaps; which permit both amazingly quick climb and slow landing speed.

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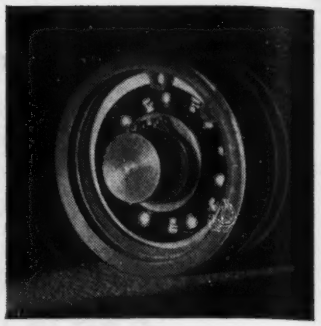

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Moreover, the non-magnetic quality of "K" Monel opens possibilities for their use in (or around) those instruments where magnetic disturbance cannot be tolerated.

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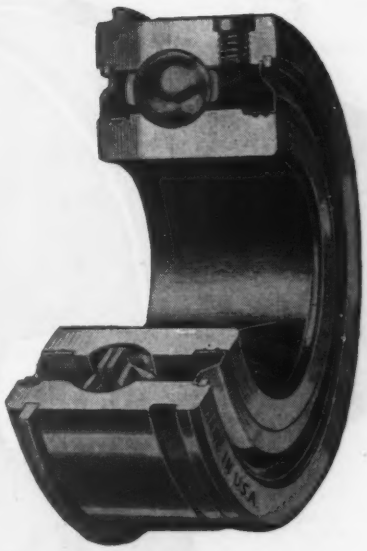

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Power plant of the Weasel is the brilliantly responsive 6-cylinder engine of the remarkably economical Studebaker Champion motor car.

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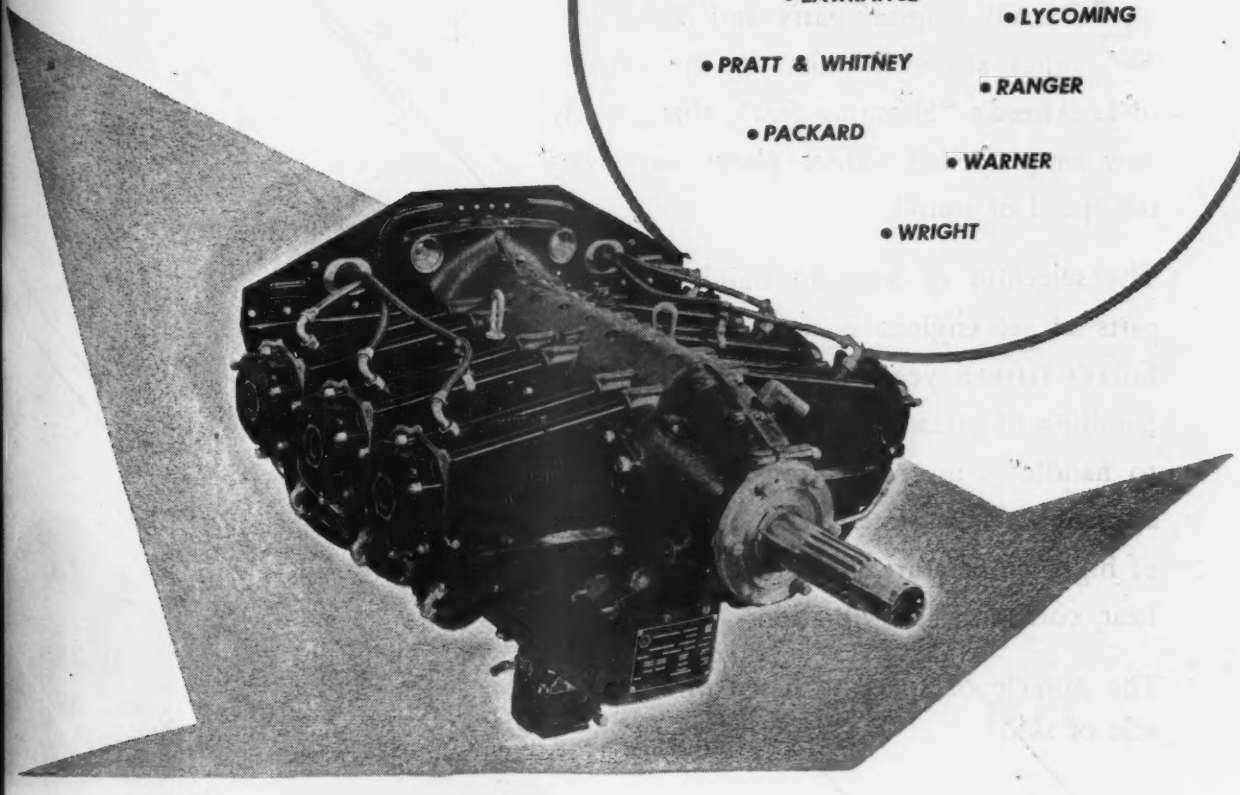

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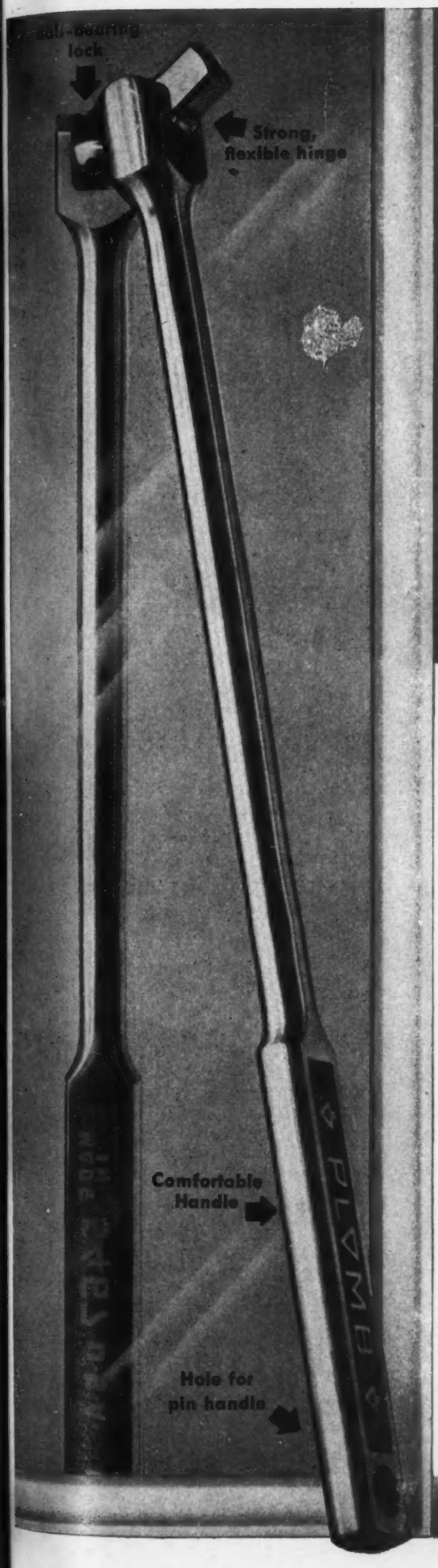

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AIRADIO'S Two-Way is compact—instrument panel mounting takes space only slightly larger than a penny postcard—can be easily serviced by removing only two screws.

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for highest quality general welding of steel plate, sheet, structural steel and piping.

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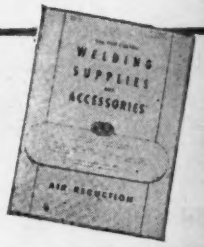

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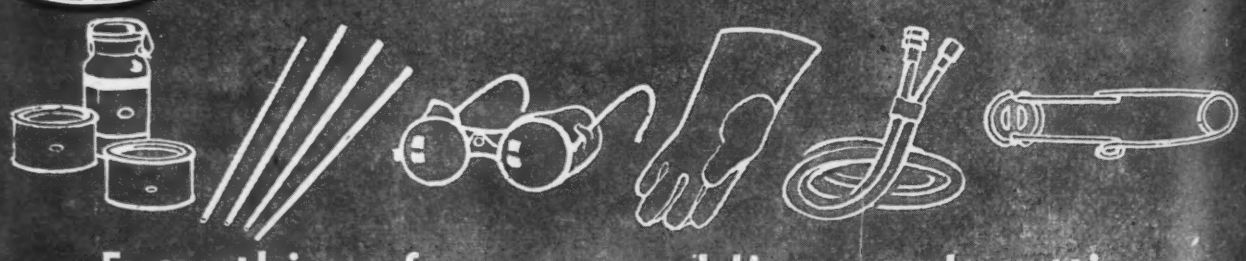
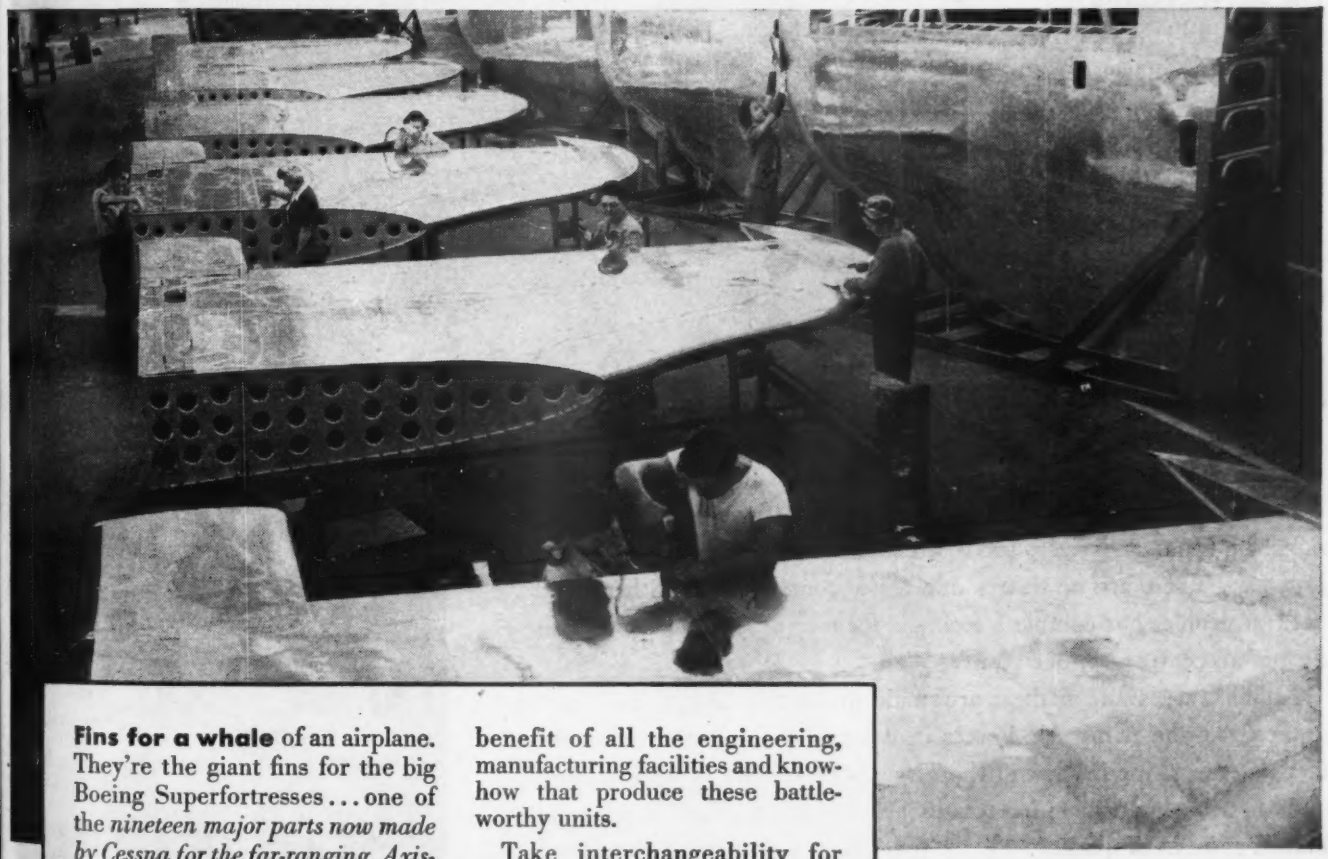


Everything for gas welding and cutting

you'll take your choice any week end

Are you a travel-tied, one-fish fisherman? Well, you won't be always. Any week end you'll be going after the "big stuff" now reserved only for two-week vacations. Mountain trout, muskies, tarpon mean Colorado, Wisconsin, Florida. Your postwar Cessna will put them all "just around the corner!" And you'll choose Cessna because your Cessna will be *Engineered for Safety* throughout.

when you CHOOSE CESSNA!



Fins for a whale of an airplane. They're the giant fins for the big Boeing Superfortresses . . . one of the *nineteen major parts now made by Cessna for the far-ranging, Axis-busting B-29's.* Cessna also makes the huge landing gears and engine cowlings for the Douglas A-26 Invader. And it's all-important to you, this high precision, all-metal wartime work at Cessna. Why? Because your postwar Family Car of the Air . . . an airplane of all-metal structure . . . will have the benefit of all the engineering, manufacturing facilities and know-how that produce these battle-worthy units.

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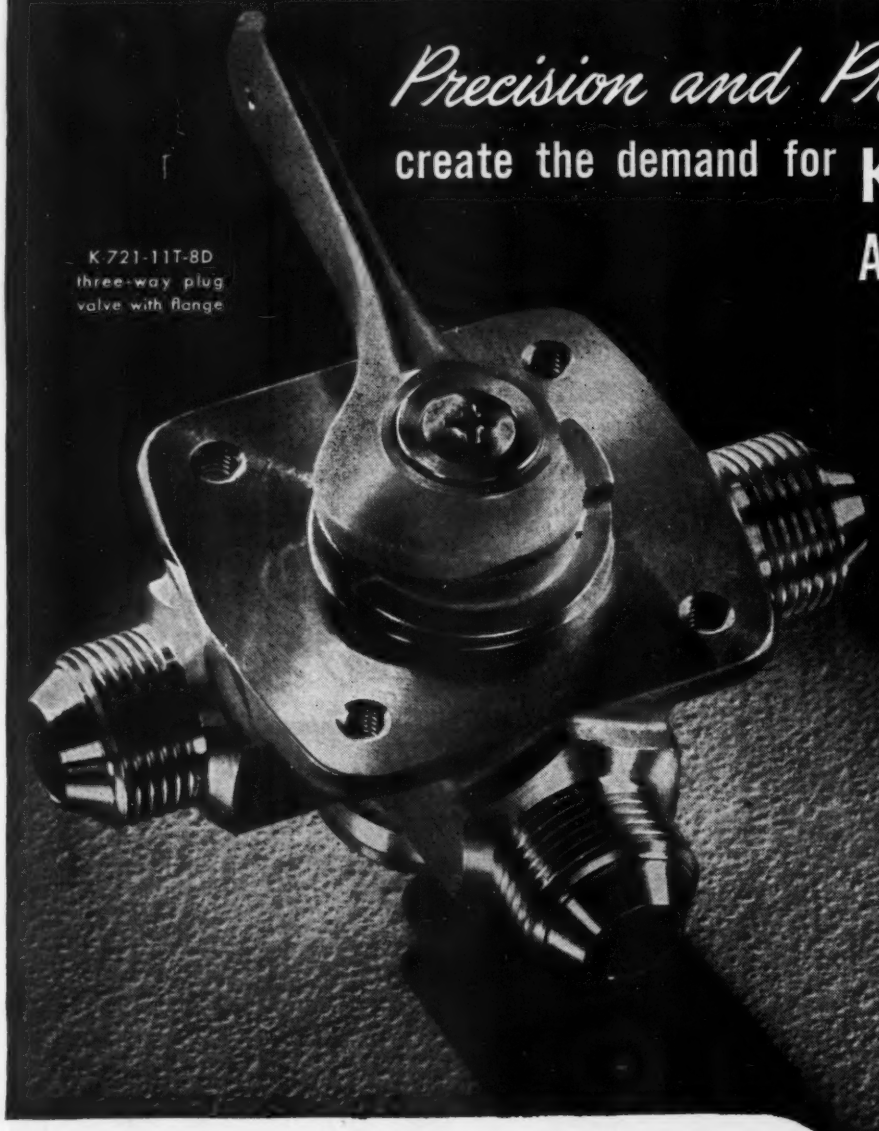
create the demand for **KOHLER**

Aircraft Valves and Fittings



K-721-11T-8D three-way plug valve with flange

PRECISION-MADE for leading aircraft companies and for the Army and Navy Air Forces, Kohler valves and fittings include a wide range of types and sizes, produced in large quantities, and *delivered promptly*. There are no delays due to subcontracting or other causes, because Kohler has complete facilities for forging, machining and anodizing, all centered in one plant.

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Write today for a *free copy* of the complete catalog: *Kohler Aircraft Valves and Fittings*. Kohler Co., Dept. AV-5, Kohler, Wisconsin. Established 1873.

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ATC "Skyloader Tactics"

will be vital to peacetime air transport

Loading crews of the Army Air Forces Air Transport Command are regularly instructed in all the uses of Skyloader equipment. For the ATC counts "Skyloading" a vital factor in insuring safe arrival of both crews and cargoes.

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Evans Sky Products are so planned that transport planes can be fitted with Evans litter stanchions, seats, cargo holddown kits, and floors, and then used for one or more purposes simultaneously.

Evans engineers are planning today for even greater progress in Sky Products in the future. For the ATC men now at war will carry over the certain value of "Skyloader Tactics" to the air transport of a world at peace.

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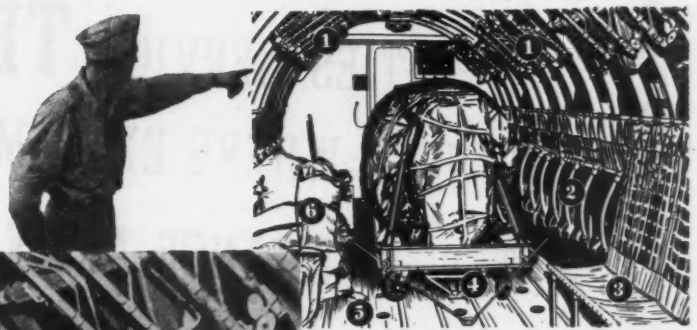

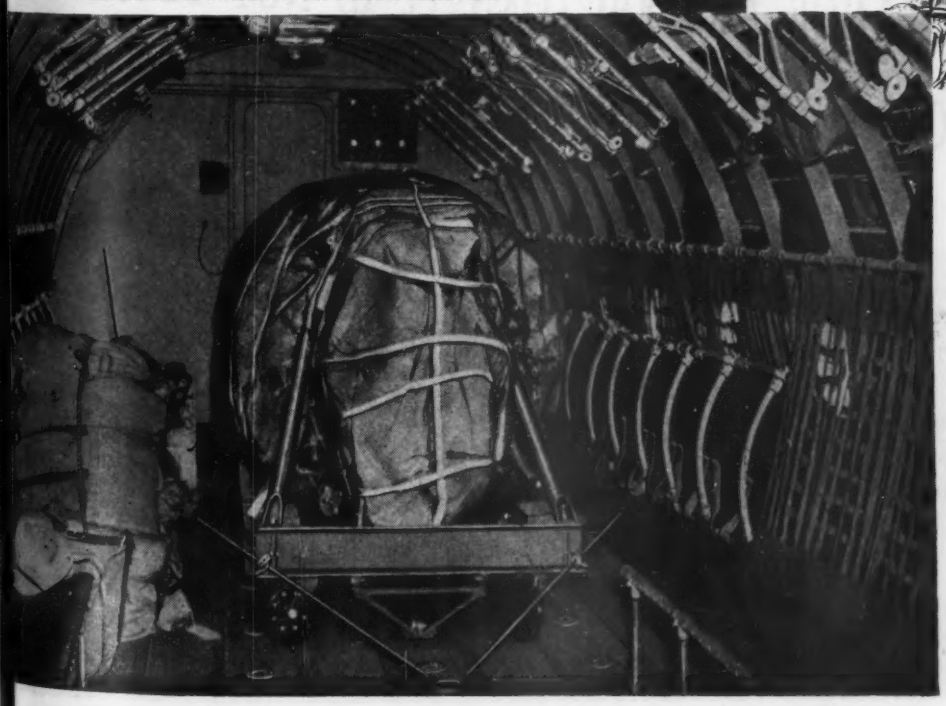

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3 Sky Seat ready for use.

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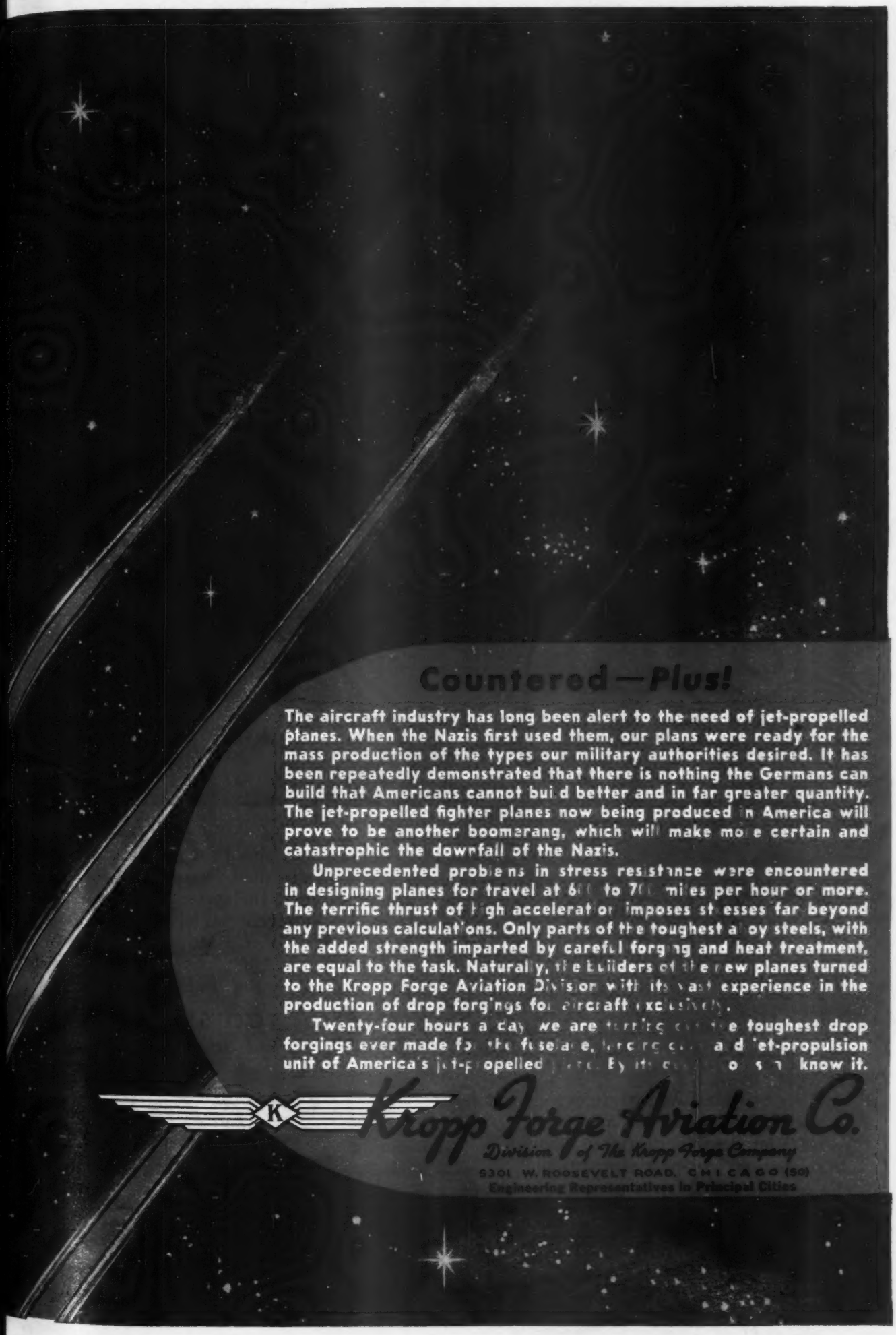
Countered—Plus!
The aircraft industry has long been alert to the need of jet-propelled planes. When the Nazis first used them, our plans were ready for the mass production of the types our military authorities desired. It has been repeatedly demonstrated that there is nothing the Germans can build that Americans cannot build better and in far greater quantity. The jet-propelled fighter planes now being produced in America will prove to be another boomerang, which will make more certain and catastrophic the downfall of the Nazis.
Unprecedented problems in stress resistance were encountered in designing planes for travel at 600 to 700 miles per hour or more. The terrific thrust of high acceleration imposes stresses far beyond any previous calculations. Only parts of the toughest alloy steels, with the added strength imparted by careful forging and heat treatment, are equal to the task. Naturally, the builders of the new planes turned to the Kropp Forge Aviation Division with its vast experience in the production of drop forgings for aircraft exclusively.
Twenty-four hours a day we are turning out the toughest drop forgings ever made for the fuselage, landing gear and jet-propulsion unit of America's jet-propelled planes. By its output you know it.
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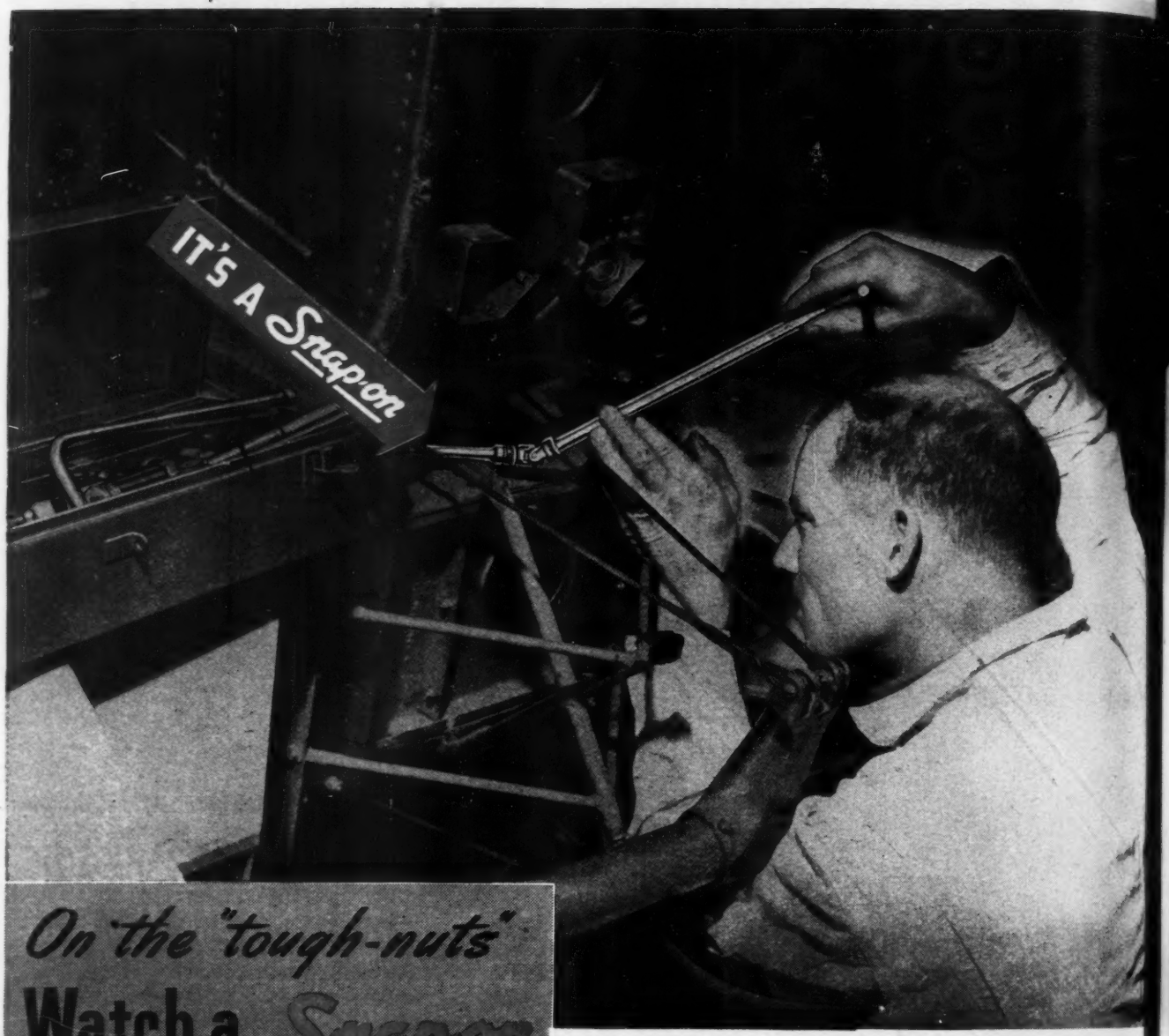

On the "tough-nuts" Watch a Snap-on Go to Work!

In the sleekly streamlined structure of a modern plane, *tough nuts* are plentiful. Blocked, hidden, fox-holed in sharply restricted spaces, they defy ordinary wrenches to "reach in and do a job".

Along aviations' assembly lines and in maintenance shops, *watch the Snap-ons go to work!* Slim, flexible, dexterous, Snap-on "combinations" by-pass obstructions, slip into tight and tricky places, grip hidden nuts securely, turn them swiftly, solidly and *safely.*

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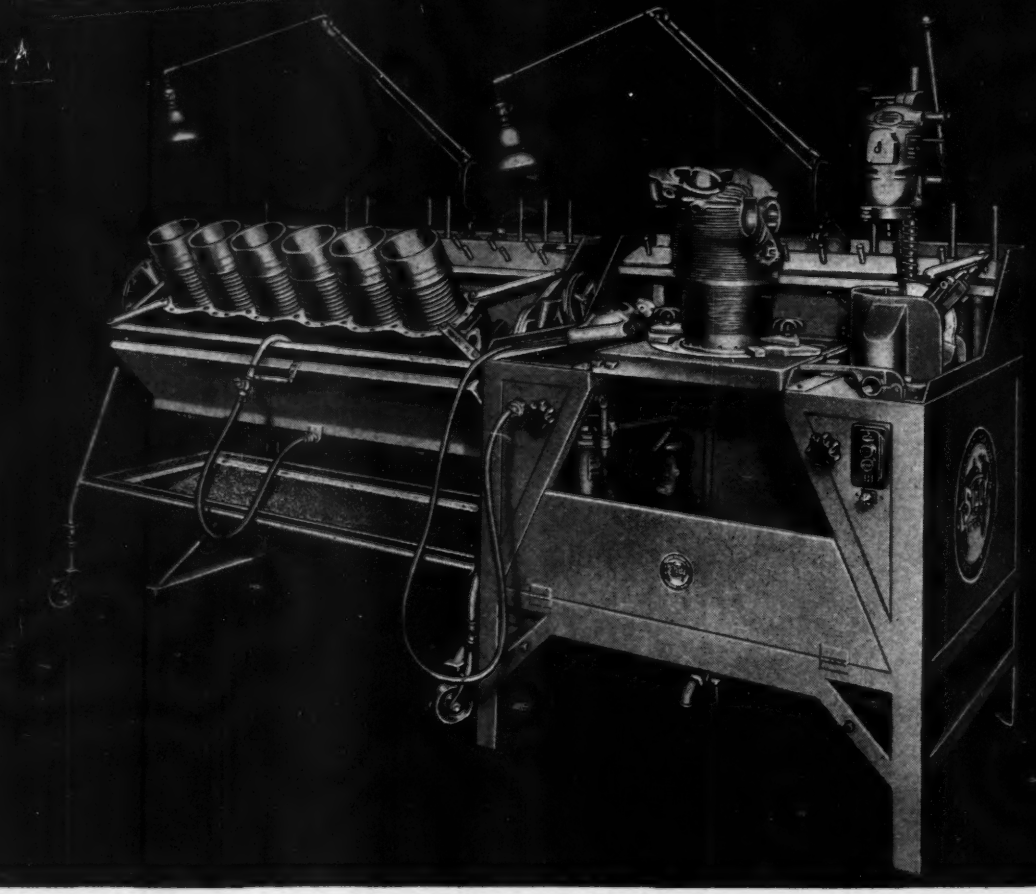

SIOUX AIRCRAFT wet valve seat grinding machine for Inline and Radial Motors

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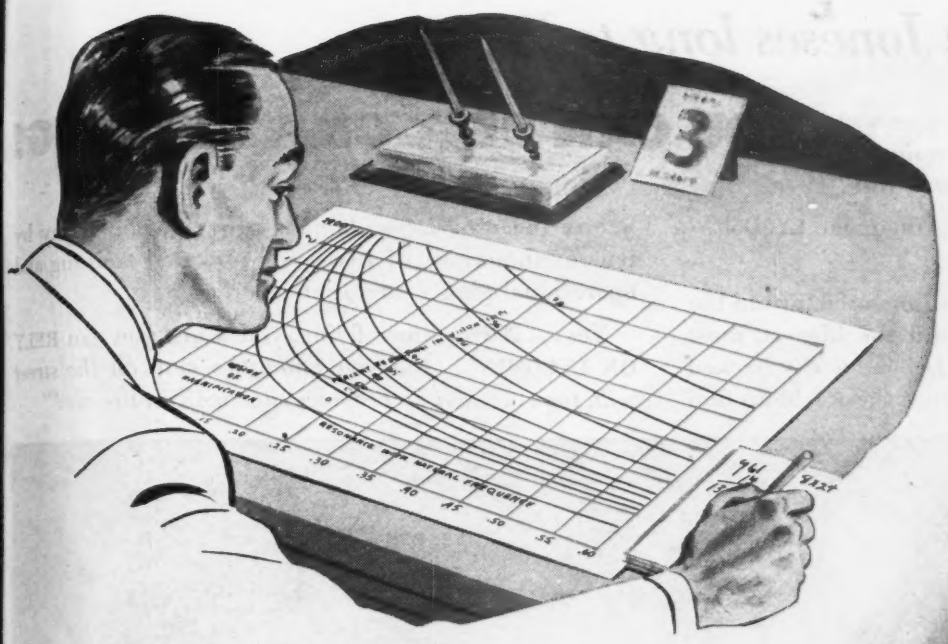
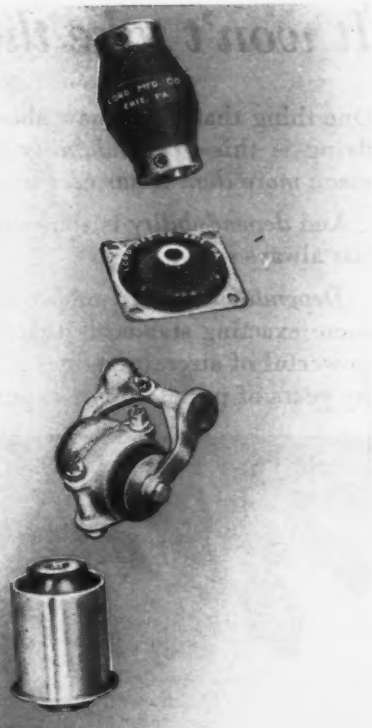
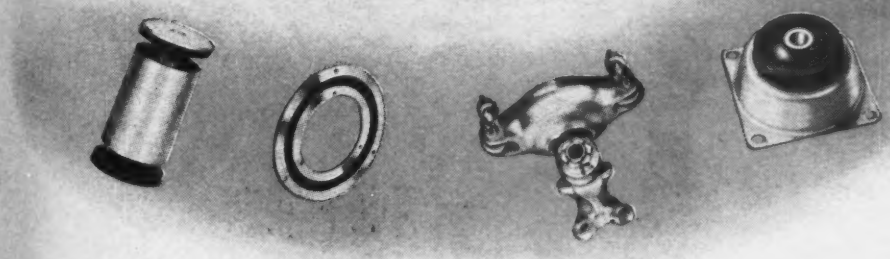




Have YOU figured the Costs of Vibration?



VIBRATION shortens the life of all types of equipment ranging from light delicate instruments to heavy, massive machinery. Vibration lowers workers' morale, slows them up, increases absenteeism. Vibration is the enemy of efficiency. Lord is the enemy of vibration.

Lord is the Pioneer and leader in the science of vibration control and isolation, and Lord Shear Type Mountings and other Bonded Rubber Products are the embodiment of many exclusive techniques and patented features developed through years of research and practical application.

The bond in Lord Mountings between metal and rubber is as strong as the rubber itself, guaranteeing against failure of the mounting under stress which the rubber itself can take.

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Lord designs and processes allow the rubber element to function in free shear without chafing, providing uniformity of action and resulting in a greater degree of vibration control.

Proper application of the Lord plan of scientific analysis and control make it possible to reduce by 80% or more, the destructive forces of vibration. Without obligation to you, Lord Engineers will make a study of vibration problems in your product, offering recommendations for its effective reduction and control.

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One thing that's sure now about post-war flying is this—*dependability is going to mean more than it has ever meant before!*

And *dependability* is something the name LYCOMING has always stood for.

Dependability born of precision manufacture to the same exacting standards that build the biggest, most powerful of aircraft engines . . . *Dependability* backed by years of private flying experience the world around before the war. *Dependability* proved again today by tens of thousands of Lycoming-powered training and operational planes during the war.

Yes . . . if you know flying, you know you can RELY ON LYCOMING. *And you know the man on the street will, too . . . when he becomes the "man in the air!"*

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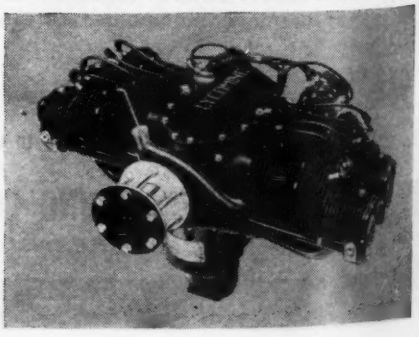

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AN AVCO PRODUCT

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ASSIGNMENT
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HYDRAULIC ACCUMULATOR DIAPHRAGM THAT WILL
• WITHSTAND HIGH PRESSURES
• REMAIN FLEXIBLE AT -65°F
• OPERATE AT +180°F
• BE UNIFORMLY PERFECT
Man's genius for making things is limited only by the physical properties of the substances used to make them

Sirvene Diaphragms are Dependable AT −65° OR AT 180°F

Temperatures, either extremely low or exceptionally high, must be considered in your requirements for pliable parts, Sirvene chemical engineers can help you. Here is a typical case: The hydraulic accumulator diaphragm is a most important part in an airplane. It is essential to the system which operates the bomb bay doors, the wing flaps and other vital hydraulic devices. By maintaining a balance between the air and fluid pressures in the system, it is the key to smooth operation. The diaphragm must remain flexible at temperatures as low as −65°F and give dependable service even at 180 degrees of heat. Specifications require that this diaphragm must be *as perfect as human ingenuity can make it.*

Sirvene engineers met this challenge by developing a special formula, using pure, oil resisting elastomers; by production methods seldom found outside a well equipped laboratory; by constant tests to maintain strict and precise uniformity; and by two-fold final inspection which eliminated any diaphragm that showed the most minute flaws . . . yet, all this care represented no departure from the usual Sirvene methods. It is *typical* of Sirvene and it is your guarantee of satisfactory performance under toughest conditions.

SINCE 1878

The Chicago Rawhide Manufacturing Co. has specialized in the manufacture of Sirvis leather products for mechanical application. In 1929, Chicago Rawhide chemical engineers began a program of research, study and experimentation to develop elastomers which would operate efficiently under exceptional conditions. Sirvene was the result, and commercial production was begun in 1935. Sirvene was then, and has continued to be, the leader in its specialized field.

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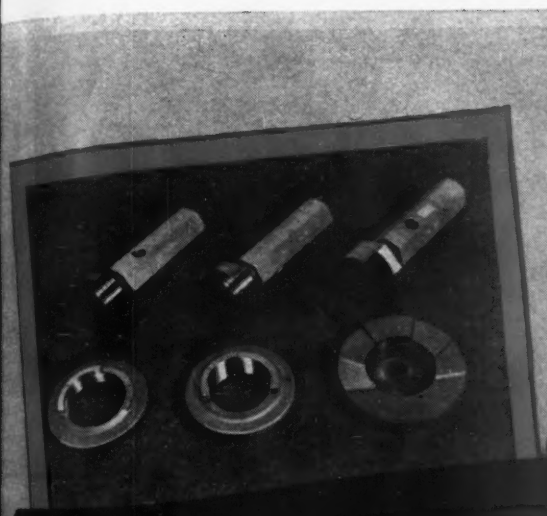
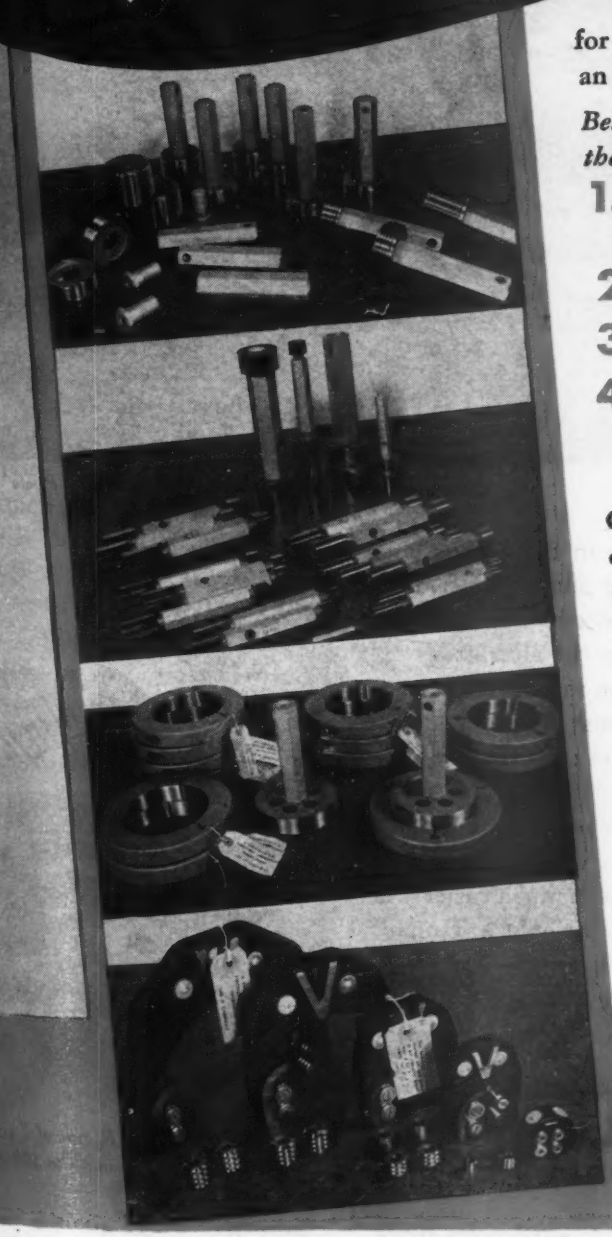


VARD INC.
PASADENA 8, CALIF.

MAKE ACCURATE LONG WEARING GAGES *From Graph-Mo Steel*



Vard Inc., have used Graph-Mo Steel for many years as material for gages that have gained an enviable record for accuracy and long service life.

Below are listed four points given by Vard Inc., as their reasons for choosing Graph-Mo Steel.

1. High production of gage blanks with minimum machine time.
2. Reduces heat treating problems.
3. Responds readily to stabilization processes.
4. Gages when finished have an exceedingly smooth surface and high polish; therefore, will give a longer wear life.

Gages are just one application where Graph-Mo, an oil hardening steel, provides outstanding performance. It is also used successfully for tools, dies, oil seals, wear plates, spindles, etc.

Graph-Mo is one of the five performance proven Timken Graphitic Steels. The others are Graph-Tung, Graph-Sil, Graph-Al and Graph-M.N.S. Each has been designed to meet specific problems. A request written on your firm's letterhead will bring a 48 page booklet that tells *where, when* and *how* to use Timken Graphitic Steels to your greatest advantage. Steel and Tube Division, The Timken Roller Bearing Company, Canton 6, Ohio.

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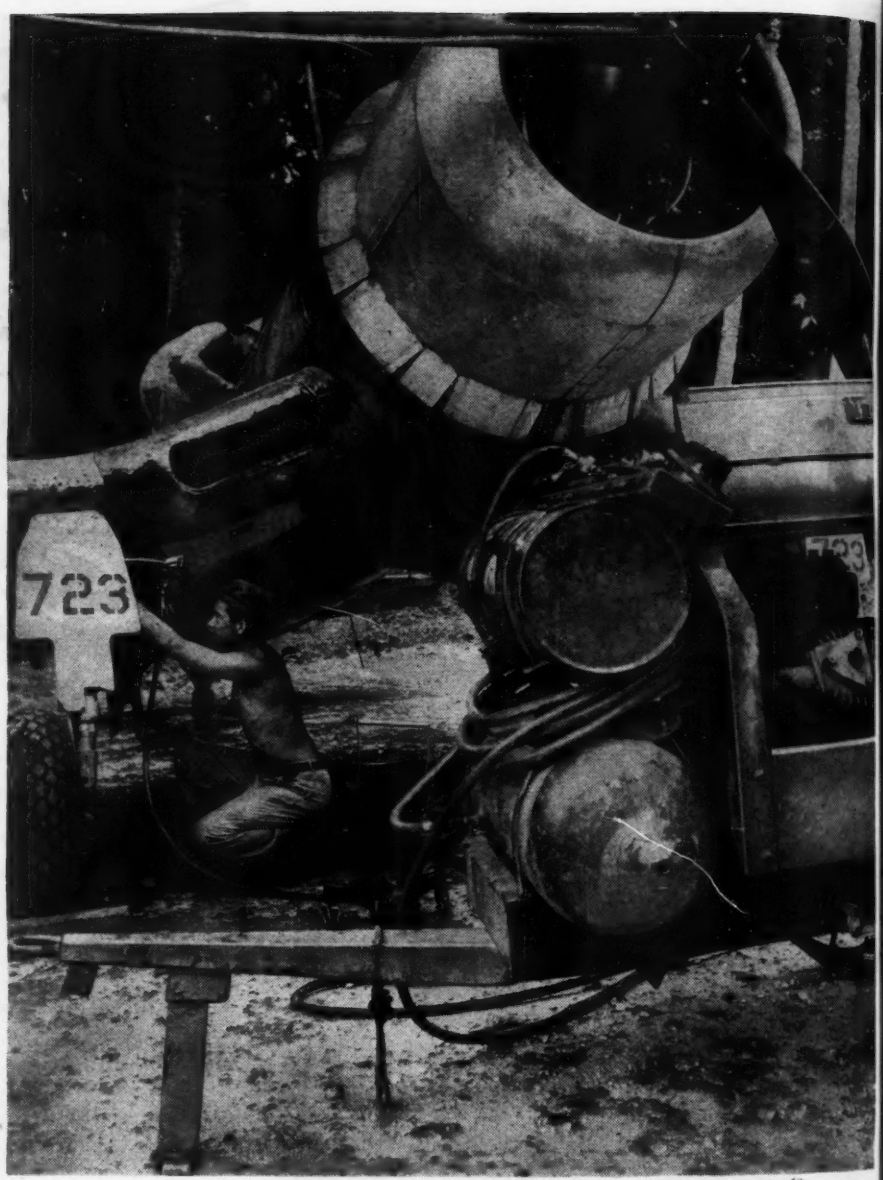
TRADE-MARK REG. U. S. PAT. OFF.
GRAPHITIC STEELS

COMPRESSED AIR *helps keep* CORSAIRS IN THE AIR



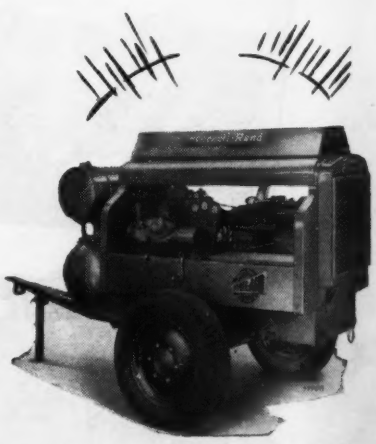
Official Marine Corps Photo

A large share of the credit for Marine successes in the Pacific goes to the ground crews at island bases. Safety of the pilot, the performance of the plane, and the success of each mission depends upon the skill and diligence of mechanics who daily service the aircraft.

Every part must be double-checked, lubrication must be thorough and complete, tires inflated, damaged planes must be patched up, and their motors overhauled or replaced, so that every available unit can be put back into the fight.

Here at an airfield at Bougainville we see them servicing a Corsair fighter with the aid of compressed air furnished by an Ingersoll-Rand D-85 MOBIL-AIR compressor. Their tasks are made much easier and done quicker by the use of Compressed Air. It is the *only* way many jobs can be done.

You will find MOBIL-AIR compressors and Ingersoll-Rand Air Tools serving the Armed Forces of the United Nations all over the world.



D-85 MOBIL-AIR, one of 7 sizes with capacities from 60 to 500 c/m.

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American industry has been quick to utilize the new Dow Corning Silicones—to see the potentialities inherent in their higher order of heat stability, chemical inertness, water resistance, and dielectric properties. Dow Corning is now supplying, directly or through selected distributors, the following silicone products:

DC FLUIDS Water-white, odorless, inert Silicone Liquids . . . notable for their low rate of viscosity change over a wide temperature range, low vapor pressure, water repellency, and good dielectric properties.

DC 4 Ignition Sealing Compound . . . an easily applied silicone waterproofing compound having excellent dielectric properties, corona resistance, and the consistency of petroleum jelly. It neither hardens nor melts at temperatures ranging from −40° F. to 400° F.

DC 7 Special Low Temperature Compound . . . an oxidation resistant lubricant and sealing compound developed for use at temperatures as low as −70° F.

DC 31 A lubricating Silicone Grease for special applications in the temperature range of −70° F. to 190° F.

DC 41 A lubricating Silicone Grease for special applications where operating temperatures range from 0° F. to 400° F.

DC 993 Insulating Varnish . . . recommended because of its extreme heat stability for impregnating, coating and bonding, and waterproofing inorganic insulating materials such as asbestos, mica, and Fiberglas cloth, tape, and sleeving. Other special purpose silicone resins and compounds are available.

DC STOPCOCK GREASE A chemically resistant Silicone Grease for lubricating stopcocks and other ground glass joints.

DC PLUG COCK GREASE A Silicone Grease that affords easy operation of lubricated plug valves over wide temperature ranges in most difficult services.

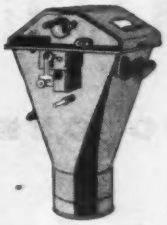
DOW CORNING CORPORATION
MIDLAND, MICHIGAN
ADDRESS ALL INQUIRIES TO BOX 592

Dow Corning

FIRST IN SILICONES

PRECISION AERIAL PHOTOGRAPHY MAPS THE ROAD TO VICTORY...

World War II has seen tremendous strides in aerial photography — potent weapon of modern war. Fairchild Camera and Instrument Corporation has played a leading role in the development and perfection of the precision aerial camera. The Fairchild model presented in this milling story is the K-18 — designed expressly for high-altitude intelligence photography, requiring large area coverage and large image size. Intended primarily for vertical photography, it is also used for low-altitude obliques. Equipped with lens of 24-inch focal length; 9 inches by 18 inches negative size; fully automatic or manual operation.



Fairchild CAMERA

— Photo and data: courtesy Fairchild Camera & Instrument Corp.

Milling a film magazine seating surface for the Fairchild K-18 camera with special fly cutter on Milwaukee 3-H Vertical Milling Machine. Material: magnesium alloy; speed: 1500 rpm; feed: 7⅝ inch per minute; cutter: 3-inch diameter with 2 tool bits; larger diameter tool bit: positive rake 20°, helix angle 15°, holder 3 inch, set-in 3½ inch; bottom tool bit: helix angle 0°, positive rake 25°, holder 3 inch, set-in 2 inch (cuts ½-inch lower than larger diameter tool bit); path, cutting distances: 20 inches wide x 15 inches across, cutting four sides; supporting wall 3/16 inches thick; 10 minutes milling time.

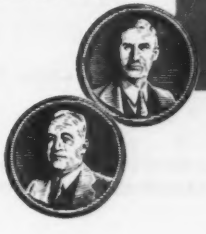
PRECISION milling of thin walled magnesium and aluminum castings is difficult. Mirror finishes are usually a must, notwithstanding the amount of stock to be removed.

On this Vertical Milwaukee Milling Machine the rate of cross feed is exactly the same as the rate of table feed—resulting in a uniformity of surface and mirror finish over the entire milled area.

Milwaukee Milling Machines are especially adapted for this type of operation. Their three bearing spindle mountings assure smooth vibrationless operation at the sustained high speeds usually used in milling these metals.

TO MILL IT WITH SPEED ... PRECISION ... PROFIT
— PUT IT ON A

Milwaukee

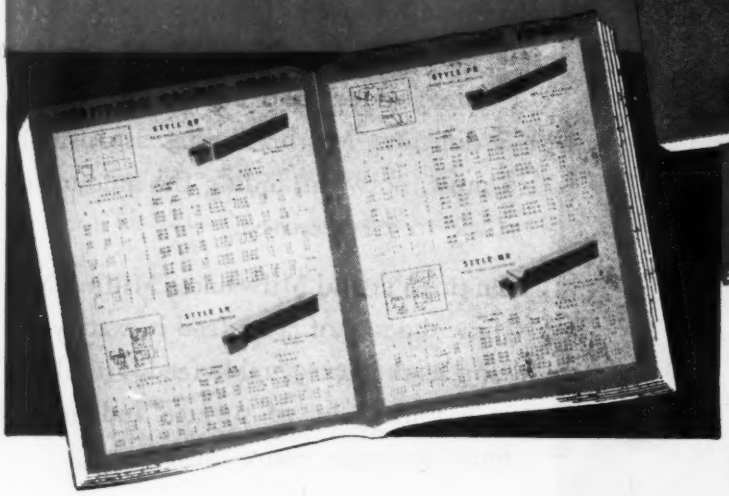


KEARNEY & TRECKER CORPORATION
MILWAUKEE 14, WISCONSIN

An Important Addition

TO OUR LINE OF

Cutting Materials



JUST OFF THE PRESS

Complete information and prices on Carmet Tools and Blanks, data on Tool Shank Steel, etc., in easy-to-follow tabular style.

ADDRESS DEPT. A-33

Send for your copy

OUR research work has always been strongly identified with cutting materials. With the various high-tungsten types of High Speed Steels as the starting point, followed by the development of the "moly" types, Allegheny Ludlum technicians later originated the patented DBL low-tungsten analysis of High Speed Steel, which has played a major role in wartime tungsten conservation.

Years earlier, our Laboratories did much basic development work on carbides, when they were first introduced in this country. At that time, we registered the trademark "Carmet." Now, with the re-establishment of our Carbide Manufacturing Division, an advanced and complete line of Carmet carbide-tipped tools and carbide metal blanks is available, thoroughly researched and effectively enhancing Allegheny Ludlum's service to users of cutting materials. We invite your attention and inquiries.

Allegheny Ludlum
STEEL CORPORATION
BRACKENRIDGE, PENNSYLVANIA

W&D M

Signed and Engineered for
pid, Positive Clamping, Maximum Open Clearance
DANLY
Kwik-Klamp
TOGGLE CLAMPS
To Speed Assembly, Machining Operations, Metal and Plastic Stamping.
For complete data, including tested pressure figures, send for the new Kwik Klamp Catalog.
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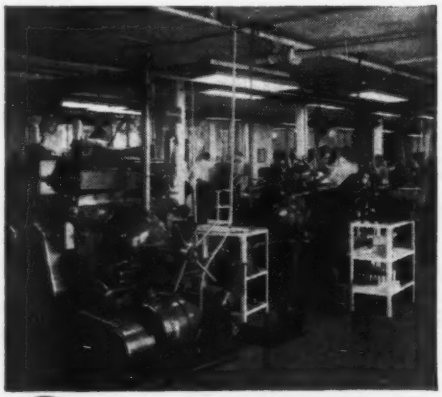
HOW TO REDUCE THE HIGH COST OF PLANT ACCIDENTS

Correct lighting—with properly applied G-E Lamps—offers important new savings in man-power and materials. Here are specific results:

1 **Machine Operators** work faster and safer in this plant using high-level, eye-easy illumination provided by G-E Mazda Lamps. Good machine lighting promotes safety, reduces accidents.

2 **Overcome Visual Strain** and watch your rejects go down! G-E Lamps, above, furnish high intensity illumination at low brightness . . . enable new workers to learn faster, make fewer errors.

3 **Handling Materials** on fast-moving machinery calls for caution—*plus* adequate glare-free lighting for safety. G-E Mazda Lamps help provide it in this wood-working shop.



4 **Production** hits top speed here—thanks to an even spread of diffused G-E Fluorescent lighting that reaches into those dark corners where the accident potential is highest.

TURN TO G-E: Whether it's lighting for safety . . . or more production at lower cost . . . or for lighting that can make postwar products sell quicker and easier . . . General Electric makes the lamps for every lighting need. Call on your G-E lamp supplier.

REMEMBER: Safer production starts with good lighting—and good lamps are the heart of good lighting. Be sure the lamps you buy are marked G-E.

G-E MAZDA LAMPS

GENERAL ELECTRIC

BUY MORE WAR BONDS

Hear the G-E radio programs: "The G-E All-Girl Orchestra," Sunday 10:00 p. m. EWT, NBC; "The World Today" news, Monday through Friday 6:45 p. m. EWT, CBS; "The G-E Housepatty," Monday through Friday 4:00 p. m. EWT, CBS

ANOTHER MARTIN FIRST!

It's simple to dimple hard and brittle sheet metal with the Martin Spin Dimpler. Adaptable to any drill press capable of 15,000 R.P.M., the new tool may be used by semi-skilled or even unskilled workers.

Putting Dimples in Tough Faces

. . . with the new Martin Spin Dimpler!

NO problem, now, is the dimpling of hard and brittle sheet metals, such as Reynolds 301-T, Alcoa 75-ST and the magnesium alloys. Thanks to a new Martin tool . . . the Spin Dimpler . . . these metals are being dimpled as quickly and easily as softer alloys.

The Spin Dimpler has been used at the Glenn L. Martin Co. to form 100 degree dimples for 3/32, 1/8, 5/32 and 3/16 diameter rivets in both aluminum and magnesium alloys varying from .020 to .064 in thickness. In the case of aluminum, a lubricant . . . Tycol-655 . . . is used.

A product of Martin Engineering, the new tool forms dimples by spinning rather than by pressing them into shape. Trimmer cutting edges remove any metal which is extruded upward and a pressure pad assembly holds sheet in place during the process. Dimples feature a sharp edge, leaving no void around the rivet head, and resist corrosion as well as do machine counter-sunk holes. The Spin Dimpler is now being manufactured, under license, by Topflight Tool Co., Towson 4, Md. and Schaefer Machine Co., Inc., 100 White St., Brooklyn 6, N. Y.

THE GLENN L. MARTIN COMPANY, BALTIMORE 3, MD.
GLENN L. MARTIN-NEBRASKA COMPANY—OMAHA

Martin
AIRCRAFT
Builders of Dependable Aircraft Since 1909

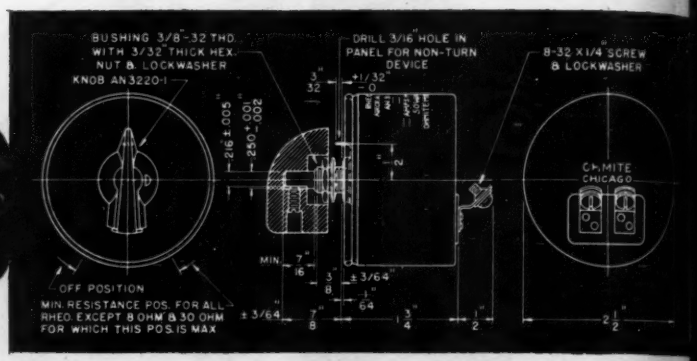
Wait a Minute, Mister!

Before you turn the page, think! Our fighting men are 100% in this war—and we're only putting 10% of our incomes into War Bonds! Isn't it time you bought an *extra* War Bond? Keep faith with your fighters and yourself . . . buy War Bonds for keeps!

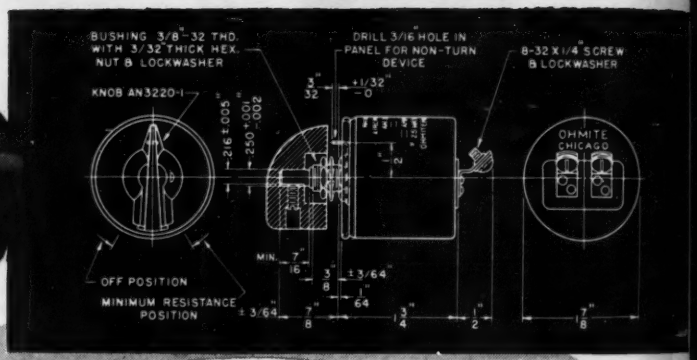
OHMITE AN3155 Aircraft Rheostats

OFFER UNIQUE IMPROVED CONTROL PROTECTION

Model "J"
50 Watt
Actual Weight with Knob .4 lb.


BUSHING 3/8"-32 THD. WITH 3/32" THICK HEX. NUT & LOCKWASHER
KNOB AN3220-1
DRILL 3/16" HOLE IN PANEL FOR NON-TURN DEVICE
8-32 X 1/4" SCREW & LOCKWASHER
OHMITE CHICAGO
OFF POSITION
MIN. RESISTANCE POS. FOR ALL RHEO. EXCEPT 8 OHM & 30 OHM FOR WHICH THIS POS. IS MAX

Model "H"
25 Watt
Actual Weight with Knob .3 lb.


BUSHING 3/8"-32 THD. WITH 3/32" THICK HEX. NUT & LOCKWASHER
KNOB AN3220-1
DRILL 3/16" HOLE IN PANEL FOR NON-TURN DEVICE
8-32 X 1/4" SCREW & LOCKWASHER
OHMITE CHICAGO
OFF POSITION
MINIMUM RESISTANCE POSITION

Smooth, Close Control Under Every Service Condition of Heat, Cold, Humidity, Altitude, Shock, Vibration

These new Ohmite AN3155 aircraft units are more rugged, more dependable than ever . . . yet they are lighter in weight than the allowable weight specified.

The rheostats are linear or taper wire-wound in various resistances with "off-position" as required by the specification.

Each unit is totally enclosed in a compact, corrosion-resisting metal enclosure. The construction of the drawn metal enclosure is unique in that after the rheostat is in position, the cover is permanently fastened by means of a "double-seam." The terminals are brought out through a sealed terminal board.

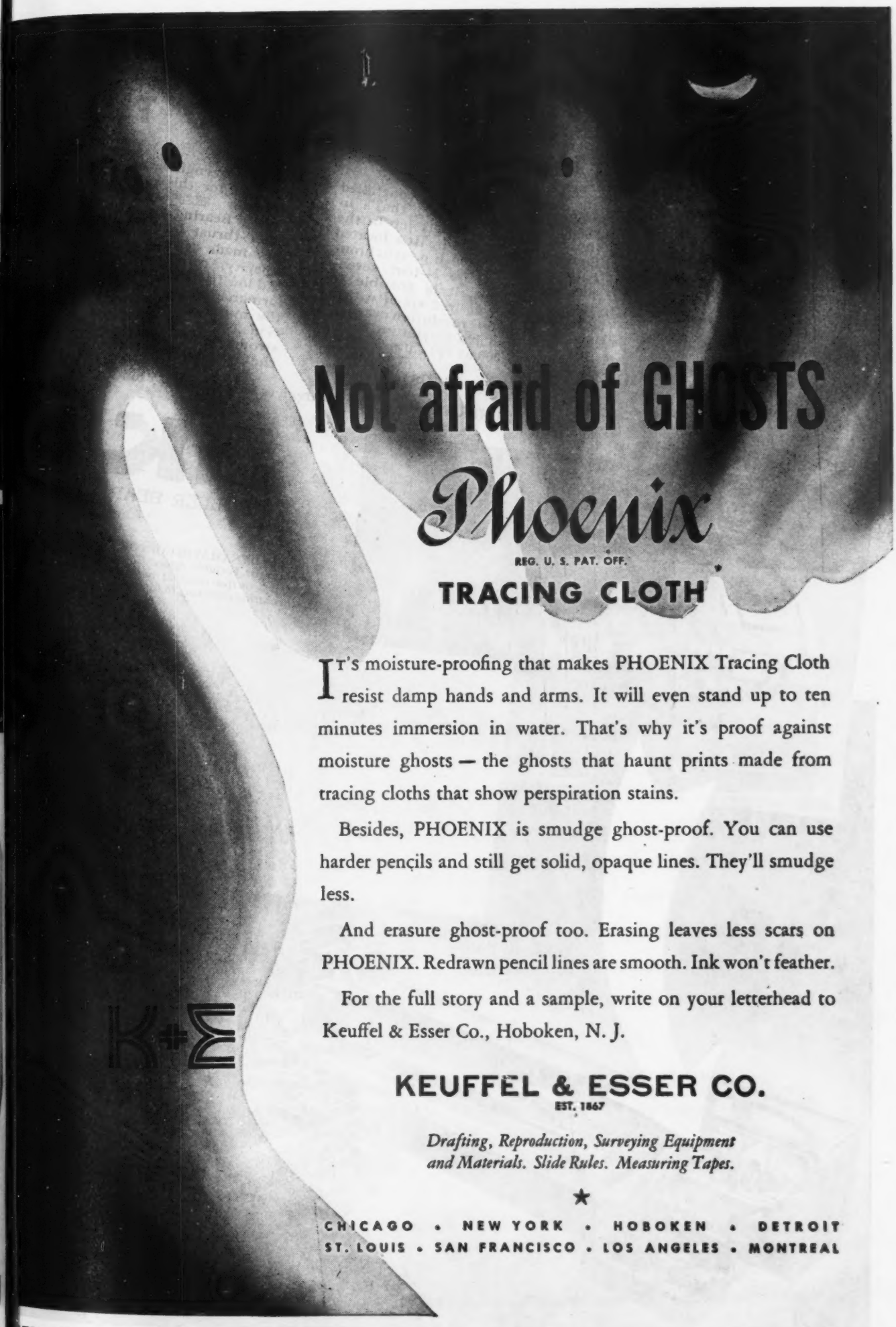
Among the many tests which these AN units meet are the salt spray corrosion test, and the test for satisfactory operation in the temperature range from −55°C. to +70°C. (−67°F. to +158°F.)

Write today on company letterhead for Bulletin No. 124.

OHMITE MANUFACTURING CO
4945 FLOURNOY ST., CHICAGO 44, U. S. A.

Be Right with **OHMITE**

RHEOSTATS • RESISTORS • TAP SWITCHES



Not afraid of GHOSTS

Phoenix

REG. U. S. PAT. OFF.

TRACING CLOTH

IT'S moisture-proofing that makes PHOENIX Tracing Cloth resist damp hands and arms. It will even stand up to ten minutes immersion in water. That's why it's proof against moisture ghosts — the ghosts that haunt prints made from tracing cloths that show perspiration stains.

Besides, PHOENIX is smudge ghost-proof. You can use harder pencils and still get solid, opaque lines. They'll smudge less.

And erasure ghost-proof too. Erasing leaves less scars on PHOENIX. Redrawn pencil lines are smooth. Ink won't feather.

For the full story and a sample, write on your letterhead to Keuffel & Esser Co., Hoboken, N. J.

K+E

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ST. LOUIS • SAN FRANCISCO • LOS ANGELES • MONTREAL

On the Dynamatic variable speed coupling
IN THE BOEING WIND TUNNEL

Here's an electronically controlled Variable Speed Coupling that's in the middle of a tough job in the Boeing Wind Tunnel. It's located between the 18,000 h.p. synchronous motor and the 24-foot, seven-ton fan. Thus, it is possible to maintain any desired speed within one-tenth of one revolution per minute . . . to reach a maximum horsepower of 18,000 at 500 r.p.m.

Dynamatic engineers selected SKF Bearings for this unit. They used the new SKF Spherical Roller Thrust Bearing to carry full propeller thrust load. Consequently, they made certain of high bearing capacity, complete self-alignment and low friction for dependable performance at all times—even under the most adverse operating conditions. The tougher the job, the stronger the proof that SKF puts the right bearing in the right place.

5785

It is not strange, therefore, that

SKF INDUSTRIES, INC., Front Street & Erie Avenue, Philadelphia 34, Pa.

SKF
ROLLER BEARINGS

● *The SKF Spherical Roller Thrust Bearing.*

● *Built by* DYNAMATIC CORPORATION, *this eddy current Variable Speed Coupling weighs 110,000 lbs.; output rotating member, 50,000 lbs.; input rotating member, 18,000 lbs.*

Drawing by Tech. Sgt. Steele Savage, AAF, from sketch at advance base on New Guinea by Sgt. George Porter.

"BUSYBODY"

Here indeed is an engine of destruction, a projectile of vengeance, and a "Busybody" of increasing dread in its timely role of grim Nemesis to the ringtail sons of the setting Sun ...it's the newest Thunderbolt...the P47 "N".

¶ The saga of the versatile Thunderbolt should need no emphasis...since official combat figures from every fighting front stress its dominant performance. » » »

Nevertheless, it is a gratifying fact that from its latest zone of operation in the Pacific, comes welcome news that the increased range, the greater speed, and the tremendous punch of this flying Juggernaut is resulting in more missions flown and more victories per mission...both vital factors to the accelerated tempo of our victory drive towards Tokyo.

REPUBLIC AVIATION
CORPORATION

Farmingdale, L. I., N. Y. — *Makers of the Mighty Thunderbolt* — *Evansville, Ind.*

an aircraft . . .

FORGING

in which close, fine grain structure is of utmost importance

Propeller Hub Forging weighing 210 lbs. in the forging of which care must be taken to avoid any mechanical or metallurgical imperfections.

Reference Data Booklet presents many new ideas on forgings and their applications in many different types of equipment. Copies available to engineers, metallurgists and executives.

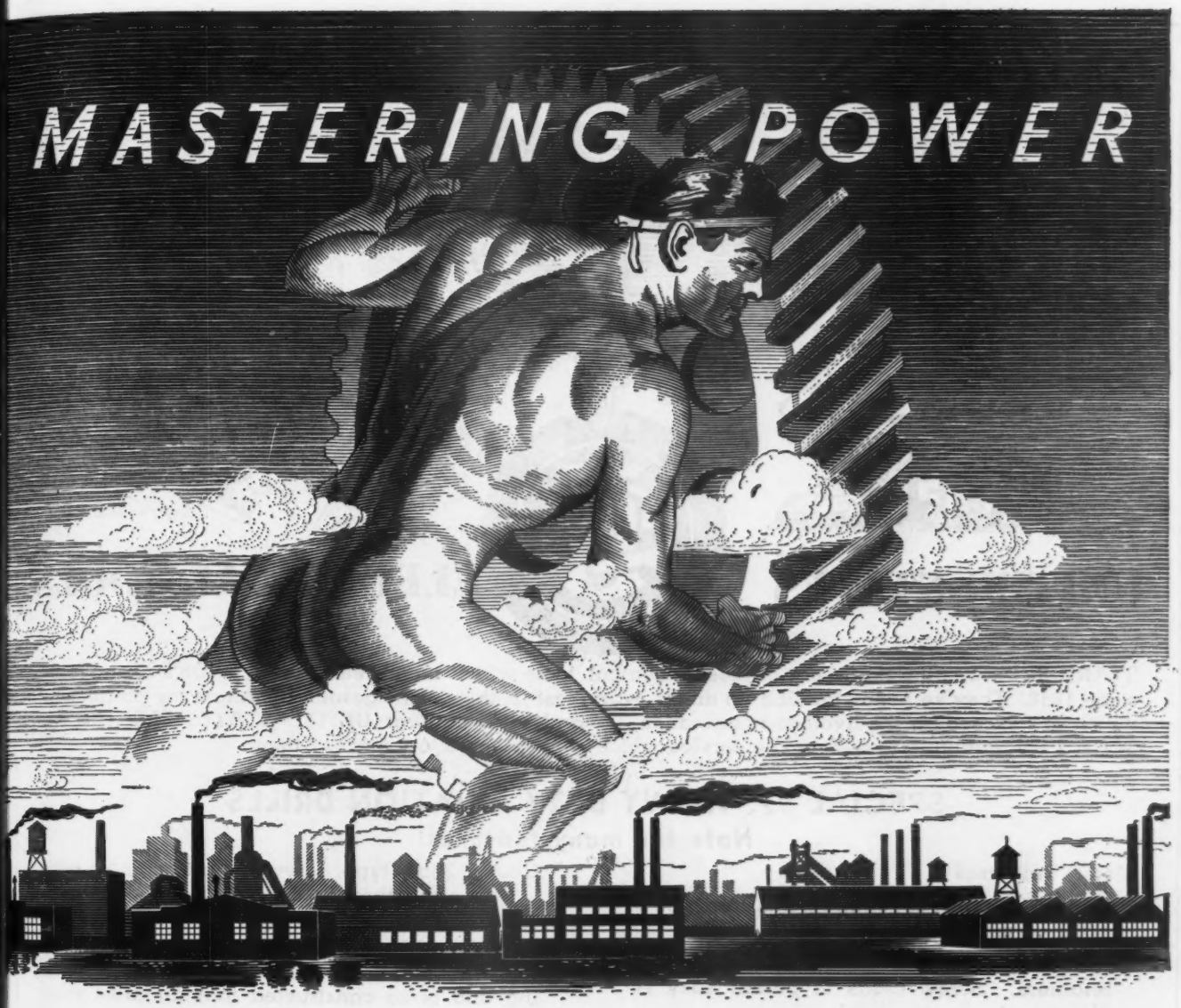
Even in a part of simple design, there may be a vast difference in the degree of *metal quality* developed by forging. A high degree of *metal quality* is of great importance in forgings subjected to severe shock and stress in actual service. *Metal quality* is inherent in the metal, but The IMPROVEMENT OF METALS BY FORGING determines the degree of *metal quality* of the forging assembled into your product. Employing the most suitable forging technique develops *metal quality* fully. Ask a Steel Improvement Forging Engineer, who is backed by 31 years of technical production effort, about the development of *metal quality* for the parts you use.

DROP FORGINGS

THE STEEL IMPROVEMENT & FORGE CO.

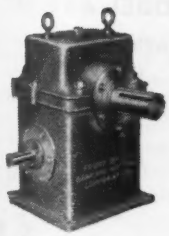
960 East 64th Street CLEVELAND, OHIO

MASTERING POWER



"A-Q" (aircraft quality) Gears

Industrial Gears



Speed Reducers

Back in 1859 when Foote Bros. was founded, America was on the threshold of a mighty industrial development. At that time many foresighted planners looked to Foote Bros. for the solutions of their problems in mastering power.

As industry developed, the demand for increased speed, greater power and more efficient methods of transmitting that power grew. And Foote Bros. met these demands.

Looking forward to new horizons of power transmission, by 1940 Foote Bros. developed a revolutionary type of gear. This gear came closer to theoretical perfection than any before achieved. It took the exacting demands of laboratory technique and translated them into mass production. Today these gears are being produced in the plants of Foote Bros. by the millions and are proving their value in the mighty aircraft engines that power so many of our fighting planes.

In the laboratory of Foote Bros. are other developments that promise better power transmission to industry after the war. Some of these are well on the road to mass production—others are little more than promising experiments.

For your production today—for the equipment you are planning to manufacture in the future—the advanced engineering in power transmission developed in the laboratories of Foote Bros. may offer solutions to the problems you face.

FOOTE BROS. GEAR AND MACHINE CORPORATION, Dept. G, 5225 S. Western Blvd., Chicago 9, Ill.

FOOTE BROS.

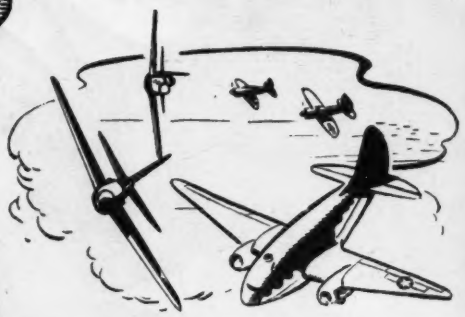
Better Power Transmission Through Better Gears

A copy of this informative product engineering manual on "A-Q" gears will be sent to you on request.

For Meritorious Service In Action

ON THE HOME FRONT

ON THE WAR FRONT



UNITED STATES ELECTRICAL TOOLS

STAND BY! . . . is the battle cry of these electrical tools which have been the STANDBY of industry since 1898. They've been standing up under every test in the most rigorous demands for production which are exceeding the liveliest imagination . . . and after the war UNITED STATES ELECTRICAL TOOLS will continue to deliver the service which you've come to expect of them.

SPECIAL ½" HEAVY DUTY AVIATION DRILLS

Note the many features:

Motor: Universal

Speed: to meet your requirements from 700 to 5,000 r.p.m.

Bearings: ball-bearing throughout, set in steel retainers. Screw plugs to permit easy replacement.

Switch: with locking pin in center of trigger, near the end. Can be used by right-hand or left-hand operator.

Cable: 15-ft., 3-wire with special rubber type protector in handle of drill. One wire for grounding drill.

Chuck: 3-jaw type, screwed on to spindle with right-hand threads.

Ample clearance between field laminations and motor housing to provide a free flow of air. A baffle plate is mounted in the motor housing and is so constructed that air must pass around the fields and over the armature thus preventing overheating.

The rear cap over commutator is held in place by two small screws and can be removed easily for quick commutator inspection, replacement of brushes or adjustment of brush holders.

MODEL 14 ARD ¼"
WEIGHT 4¾ LBS.
7½" LONG

THE United States ELECTRICAL TOOL CO.
CINCINNATI 14, OHIO

MODEL ARS ¼"
WEIGHT 3¾ LBS.
7½" LONG

"I saw a dump truck fly away..."

"First they backed an Army truck up the ramp into a Boeing C-97... Then after other loading was completed they hoisted the ramp, closed the doors, *and the fuselage became pressure-tight for high altitude, pressurized flight.*"

PRESSURIZED FLIGHT! Two words that define a new age of air travel! For a postwar adaptation of the C-97, to be known as the "Boeing Stratocruiser," will carry its passengers through the sub-stratosphere... faster, higher and in undreamed of comfort. The cabin pressure controls of the pressurized Boeing B-29 and C-97 planes were engineered, developed and are being produced by AiResearch Manufacturing Company, Los Angeles and Phoenix.

ARMY E NAVY

"Where Controlled Air Does the Job" Automatic Exit Flap Control Systems • Temperature Control Systems • Engine Air Intercooling Systems • Cabin Pressure Regulating Systems • Supercharger After-cooling Systems • Engine Oil Cooling Systems

AiResearch

DIVISION OF

THE GARRETT CORPORATION

UNIONAIR RESPONSIBILITY

will continue to govern our production of

ELECTRICAL SYSTEMS FOR LIGHT PLANES

just as it has been our watchword during the war, in the production of

ELECTRICAL ASSEMBLIES FOR MILITARY PLANES

WRITE FOR NEW BOOKLET
"ELECTRICAL ASSEMBLIES MADE TO CUSTOMERS' SPECIFICATIONS"

ARMY E NAVY

UNIONAIR

Electrical Assemblies — Hydraulic Fittings — Conduit Fittings — Junction Boxes

UNION AIRCRAFT PRODUCTS CORP., NEW YORK

NEW WELDING CONTROL

New CR7503-C110 welding control. Inset shows the master control station, which can be removed for mounting on the welding machine.

GOOD FOR ALL 3

SPOT
PULSATION
SEAM

Accurate timing • Smooth heat adjustment • Fully electronic

As this control is of the synchronous-precision type, it provides the accurate repetitive timing, even with instantaneous or sustained line-voltage variations, so essential to highest-quality welding. This control, the most versatile of all G-E resistance-welding controls, is not only ideal for the types of work given below, but it can also be used where it is desirable to do all three types of work on one machine.

Spot or Pulsation Welding

This control is particularly well suited for these two types of welding because of its wide timing range. It can be used in the welding of thin-gage metals where consistent timing of as low as one or two cycles may be required, in the welding of heavy-gage metals or in projection welding where pulsation welding may be required, or in special welding applications where pulsation welding may be required with a minimum heat and cool time of one or two cycles.

The timing range in spot welding is from 1 to 30 cycles.*

In pulsation welding, heat and cool time, are independently adjustable from 1 to 30 cycles*, and the impulse-counting circuit is adjustable from 1 to 15 impulses—independent of heat or cool time settings.

*When used on a 60-cycle power supply.

Seam Welding

Good seam welding is possible with this control because the accurate timing circuit and the independent adjustment of heat and cool time (in complete-cycle steps) eliminate timing variations and transient currents. Heat and cool time are independently adjustable from 1 to 30 cycles*.

Heat Control on All 3

Smooth heat adjustment is provided by the phase-shift method of heat control. This eliminates the need for many heat points on the welding transformer. In addition, a voltage- or current-regulating compensator can be added by simple interconnections. Also, this welding control when equipped with a tempering attachment makes possible good results in the spot welding of thin-gage air-hardenable steels.

*When used on a 60-cycle power supply

Send This Coupon for Your Copy of Our New Bulletin

General Electric Company, Section D645-33
Schenectady 5, N. Y.

Please send me a copy of your new bulletin (GEA-4220). I'd like more information about this new welding control.

Name.....

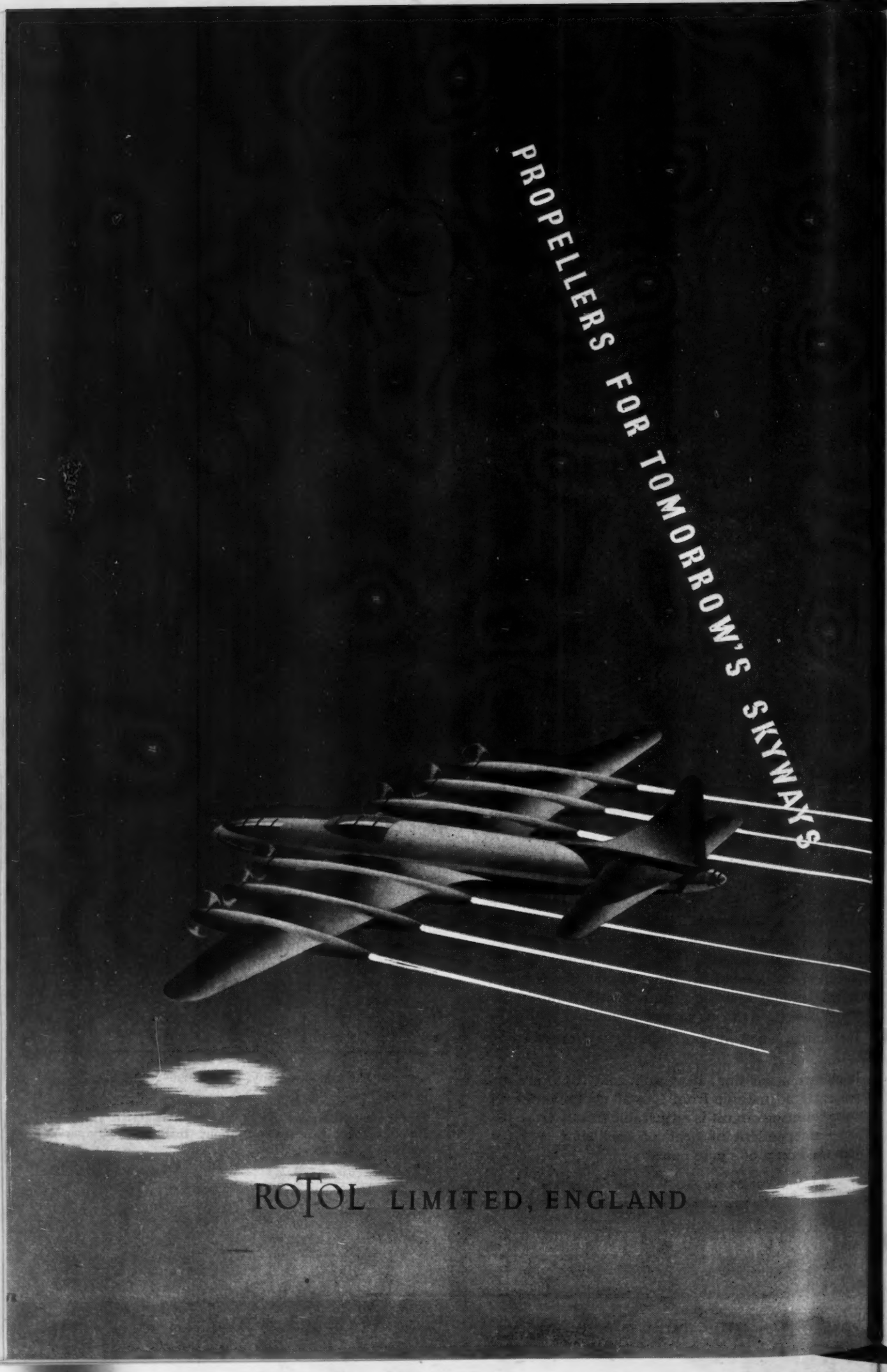
Company.....

Address.....

.....

Buy all the BONDS you can—and keep all you buy

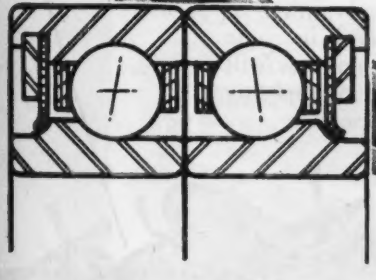
GENERAL ELECTRIC


PROPELLERS FOR TOMORROW'S SKYWAYS
ROTOL LIMITED, ENGLAND

BALL BEARING BRACELET

for a six-inch wrist

FAFNIR standardizes main rotor cyclic pitch control bearings for HELICOPTERS



ACTUAL BEARING SIZE

You can see from this full-size picture of a 6" bore Type Y Helicopter Bearing, and from the cross-section drawing in the same scale, the nature of the problem Fafnir had to solve. Thickness of section, depth of races and ball size had to be perfectly proportioned to give maximum strength with minimum size and weight. Positive sealing of lubricant is assured by the Fafnir PLYA-SEAL – a 100% effective diaphragm-type, contact seal.

Until Fafnir came up with the answer, the rotor cyclic pitch control was a helicopter headache. It needed a bearing with bracelet-thin section, that was collar-size and yet rigid enough to do a strong-arm job. Who'd ever made a bearing like this?

Fafnir had . . . the large diameter, thin-section ball bearings for controllable pitch propellers. What this helicopter "wrist" needed was more of the same . . . plus such new advances in ball bearing design as composition retainers and Plya-Seals to keep in the lubricant and keep out dirt and moisture.

That's just what the Helicopter got . . . three bearings that will handle practically any type of rotor pitch mechanism: 4", 5" or 6" bore. These Type Y Helicopter Bearings are used in pairs . . . matched at the factory . . . to give the required rigidity. Thus loads are properly distributed and the whole unit is completely sealed.

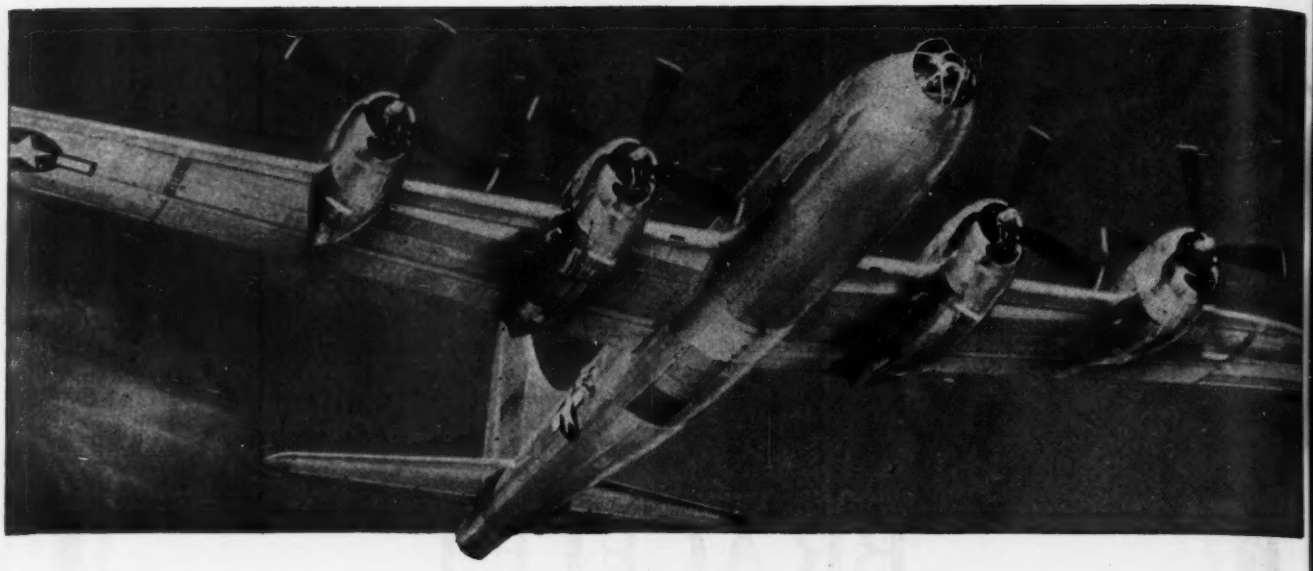
The bearing described here is but one of many Fafnir Ball Bearings now in use in helicopters. As the leader in the development of ball bearings for aircraft Fafnir is conducting continual research to develop better bearings to overcome unique helicopter problems. Write for Engineering Data Sheet 279 on these Type Y Bearings. The Fafnir Bearing Company, New Britain, Connecticut.

★ 2181

FAFNIR

BALL BEARINGS

Most complete line in America



FOR RESISTANCE TO INTENSE HEAT PLUS STRENGTH WITH LIGHTNESS

-it's Stainless Steel!

THE proved ability of Stainless Steel to withstand extremes of temperature uncalled for in any other form of transportation is the sound basis for the government directive specifically authorizing its use for "all plane parts which come in contact with exhaust gases and which are exposed to high temperatures."

The strong, tough, durable U·S·S Stainless Steel available for such critical applications retains high strength even at 1650°F. It safely absorbs the terrific thermal shock of changing temperatures that rise swiftly from the chill of dawn to the terrific heat which engines generate as they lift bomb-laden craft from the ground.

Without such steel the turbo superchargers so essential to the performance of our Superfortresses might never have been perfected.

In motor and exhaust systems, in wings and ailerons, in rudders, elevators and fuselages, U·S·S Stainless Steel can be applied to give you superior resistance to heat and corrosion, to provide greater impact and fatigue strength, to effectively resist abrasion at metal-to-metal contact points, and above all, to insure high strength-weight ratio for lightness.

Although today the use of stainless steel is restricted to those applications where it is the only material that will do the job, there is no reason why you cannot plan now to take full advantage of this superior, versatile metal in your planes of tomorrow. Our engineers will gladly cooperate with you in applying it most efficiently to your designs.

U·S·S STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS

AMERICAN STEEL & WIRE COMPANY, *Cleveland, Chicago and New York*
CARNEGIE-ILLINOIS STEEL CORPORATION, *Pittsburgh and Chicago*
COLUMBIA STEEL COMPANY, *San Francisco*
NATIONAL TUBE COMPANY, *Pittsburgh*
United States Steel Supply Company, Chicago, *Warehouse Distributors*
United States Steel Export Company, New York

★ To insure light weight, strength and heat resistance, housings for the 2,200-hp. engines of the B-29 Superfortress have many important parts made of Stainless Steel: forward collector shroud, nose ring, feed tail pipe shroud, exhaust collector, flight hood, longeron, waste gate exhaust pipe, inner cowl, nacelle shroud and side panels.

USS STAINLESS STEEL — UNITED STATES STEEL

UNITED STATES STEEL

"My Son has me up in the Air!"

1 **It seems** that my boy in the Air Force has written to the Aeronca people, and he really has me up in the air. He tells me some fascinating things about the personal planes this company will have postwar. He talks about them as he would about a new car . . . big, comfortable lounge-type seats in one model, wing slots in another, and a type big enough for the family at a modest price.

2 **He says** that because Aeronca is 100% on war work now, they've learned as much these last couple of years as they did in more than 16 years of previous experience. They've won the Army and Navy "E" (the only light aircraft company to receive this award). All told, the story sounds like good news for air-minded people. When I write my son about it, he just answers:

3 **"Get on the beam,** Pop! Send for a couple of the booklets these Aeronca people have. One tells about their new personal planes. Another describes their plans for airfields and servicing of planes near home." It sounds as though they're putting personal planes in a class with automobiles. I'm following my boy's advice and sending for the booklets. Why don't you?

AMERICA'S PERSONAL PLANE

AERONCA

has an important message for air-minded people

Aeronca Aircraft Corporation, Middletown, Ohio
Department **A-5**

Send me your valuable booklets. Enclosed is 10c for each booklet.
(Check)

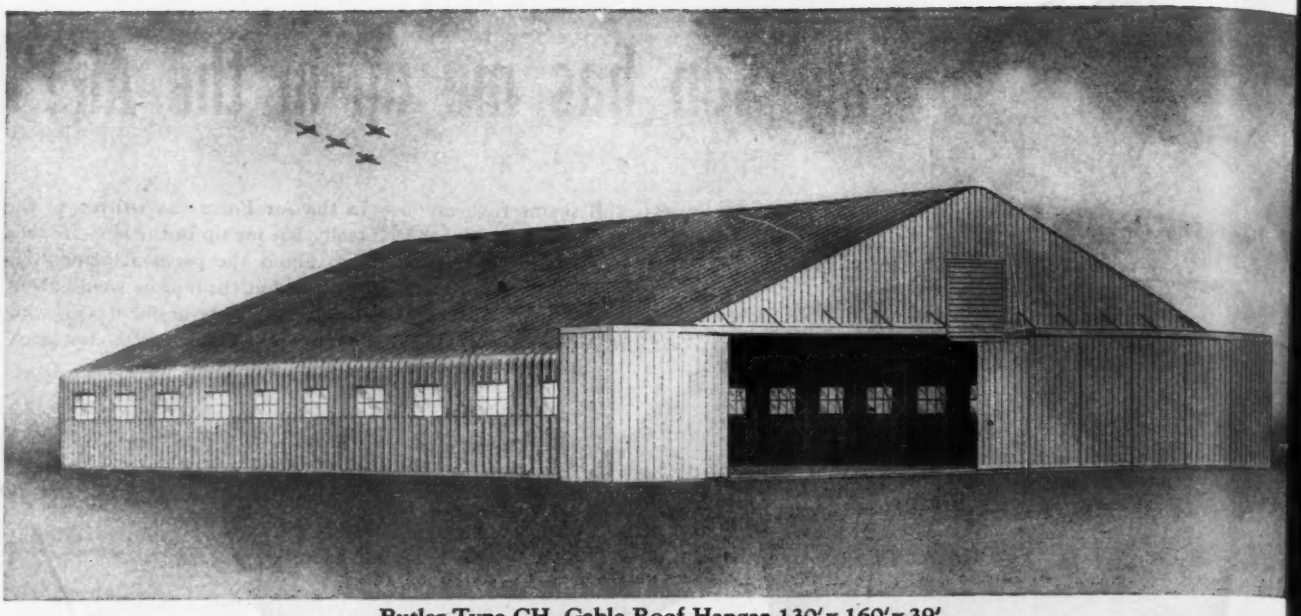
_____"Aeronca—the Plane You'll Want to Fly"
_____"How to Make Small Airports Pay with Aeronca"

Name_____

Address_____

City and State_____

Export Agency—Aviquipo, Inc., 25 Beaver Street, New York, N. Y.



Butler Type CH, Gable Roof Hangar 130′ x 160′ x 39′

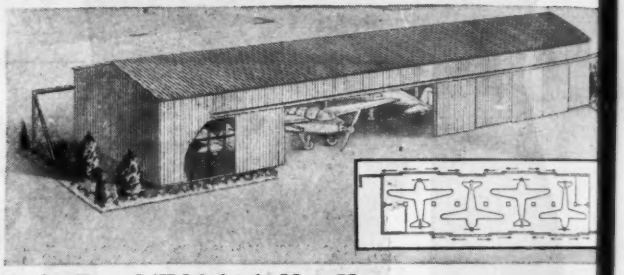
Hangars

FOR EVERY PEACETIME AIRPORT AND AIRPARK NEED

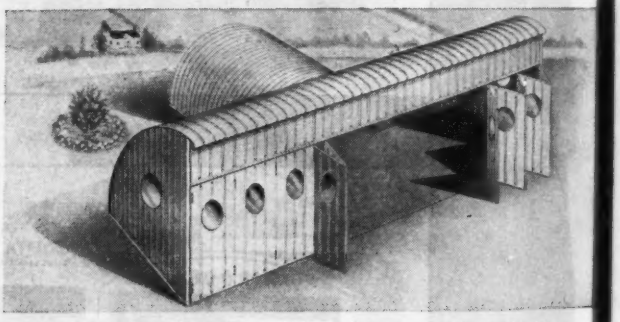
BUTLER ALL-STEEL hangars have safely housed Airplanes since the days of "Cow Pasture" Airfields. Their fabrication in Butler factories has never remained static.

During the past four years of war and lend-lease, Butler has crowded ten years of progress into the designing and methods of fabricating all-steel hangars.

From wide experience gained in the fabrication of thousands of war hangars, Butler Engineers are developing EFFICIENT, ECONOMICAL and ATTRACTIVE hangars, service and operations buildings to serve every airpark and airport need after the war.



Butler Type MT Multiple Unit Hangar
30′ wide, 12′ high, 118′ long or longer as required.



Butler Type T-RR Private Plane Hangar 40′ x 12′ x 9′
—Tail Shed 14′ x 14′ x 7′

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AIRPORT EQUIPMENT

HANGARS . . . Individual, Multiple and Commercial

BUILDINGS . . . Service and Operations

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HANGARS

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Send Booklet on Hangars for ☐ Commercial Airports ☐ Airparks

FIRM NAME_____

BY_____ TITLE_____

CITY_____ ZONE_____ STATE_____

Avigation Via Analysis

(*Continued from page* 189)

gradient winds are almost identical.

Another type of error might occur from the movement of the pressure systems themselves. It has been found that these errors are negligible. The avigator can readily make allowances for this movement, should it be necessary, by reference to a cross-section along the flight. A further use of a reliable cross-section, if the plane is not equipped with radio altimeter, is to determine the true altitude, optimum flying altitude, and wind component (C_n). By means of lines of constant forecasted altimeter corrections plotted on the cross-section, the true altitude is derived by simply adding (algebraically) the altitude correction of the plane's position to the reading of the pressure altimeter set to 29.92 in. The resultant wind depends upon the reliability of the meteorologist's forecast from which the cross-section was drawn.

The meteorologist's work most familiar to avigators is the data principally computed from the horizontal component of air qualities. Less well-known are the studies made of the vertical distribution of these factors which have to do with principles of thermodynamics. The great increase in distribution of weather stations and the development of new electronic recording instruments makes available a richer store of information than can be derived from a horizontal analysis.

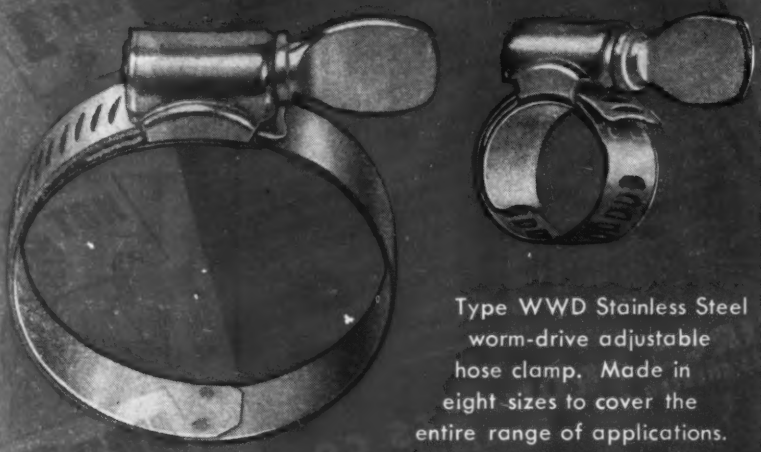
For example, the rate of increase or decrease in temperature and moisture in vertically moving air is tremendously greater than in horizontal changes. While a pressure decrease in horizontally moving air is seldom more than 5 mb. in 100 mi., the pressure decrease with altitude is approximately 500 mb. in the first three or four miles above the surface.

The vertical charting of air—severely complicated by the inconstancies of its qualities and the reduction of these qualities to relatively stable values—can be arrived at only by mathematical adaptations which may appear too attenuated for the present-day practical-minded avigator. We have seen that there are several "kinds" of altitudes. Some are a function of temperature, which in turn, is a function of the almost-unpredictable action of water vapor. Meteorological data would become quite unmanageable were it not susceptible to expression in "conservative" quantities.

Potential temperature and specific humidity are used in the method developed by Prof. Rossby of Massachusetts Institute of Technology. Potential temperature is the temperature the air

For Utmost Dependability...

WITTEK *Aviation* HOSE CLAMPS



Type WWD Stainless Steel worm-drive adjustable hose clamp. Made in eight sizes to cover the entire range of applications.

Type FBSS Stainless Steel hose clamp. The most widely used hose clamp in the aviation industry. Made in the standard AN 748 sizes . . . also additional sizes for special requirements.

Dependability has been recognized by the Wittek Manufacturing Company during its 25 years of hose clamp manufacturing experience as a foremost requirement in any hose clamp design. Wittek assures this dependability by the selection of basically sound designs . . . the use of high-grade materials and the application of good workmanship. Today Wittek offers two distinctly different hose clamp designs—each of which meets the requirements of Specification AN-FF-C-406 A.

TYPE WWD—an adjustable worm drive hose clamp made of stainless steel and designed to take full advantage of the superior physical properties of that material. Note the compact streamlined housing . . . the hardened one-piece thumbscrew—PLUS a new exclusive Wittek feature—an inner band of Stainless Steel accomplishing the two-fold purpose; (1) protecting the hose from the serrations in the outer band, and (2) distributing the load uniformally to provide greater strength and superior sealing characteristics.

TYPE FBSS—an improved Stainless Steel version of Wittek's basic FB design—now incorporating a bridge extender—in all sizes. This is the most effective hose clamp for all applications where an adjustable clamp is not necessary.

Hose Clamps for all requirements, made by Wittek—specialists in hose clamps and their applications.

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War Bonds for Victory . . Buy More Than Ever Before!

WITTEK
MANUFACTURING CO.
4305-15 W. 26th Place, Chicago 23, Ill.

Aviation HOSE CLAMPS

would have if reduced adiabatically to a pressure of 1,000 mb. (10^6 dynes per $cm.^2$) and is the ordinate of the Rossby diagram. Specific humidity is the abscissa. Other lines, such as equivalent-potential temperature (a function of potential temperature and specific humidity) are also used. Another method—the tephigram—employs temperature (usually in degrees C.) and the almost indefinable quantity, entropy. Applied to a unit mass of a substance, and thereby known as specific entropy, it may be expressed in differential form, $d\phi$, signifying the change in entropy. Where dq is the heat added to a unit mass and T the absolute temperature, $d\phi = dq/T$.

Therefore, when entropy does not change, there is a reversible process called isentropic. In general, entropy may be regarded as proportional to potential temperature. As with energy, it is not the absolute value of entropy which matters, but rather the changes. The ordinate of the tephigram is entropy, and sometimes, also, the logarithm of potential temperature. The abscissa is temperature.

It is unnecessary to dwell further upon the importance of the quantities mentioned. The phenomenon of the atmosphere can be comprehended in terms of the fundamental first and second laws of thermodynamics. From the vicissitudes of an invisible media, the avigator can find the data which tells him precisely what this air—the omnipresent thermodynamic machine—intends as he rushes through its vital substance. Transporting the sun's heat from one region of the earth to another, transferring it into unimaginable quantities of kinetic energy in turn dissipated by friction and transformed again into heat that is lost in radiation to space, the air's enormous power and intricate ways can be a source of exploitation to the skilled avigator.

Review of Patents

(*Continued from page* 202)

Automatic Releasing Hook for aircraft catapulting mechanism is designed to disengage without supervision by attendant when catapulting force is overcome by forward movement of plane. Hook is provided with tail of considerable weight to rotate hook out of engagement with pulling cord when latter becomes slack.—2,369,455, filed June 24, '41, pat. Feb. 13, '45, A. Grause.

Propeller Mounting comprises spherical elastic member located near center of gravity of propeller, carried by power shaft and supporting propeller hub, forming merely a center for propeller without materially insuring transmission of torque or axial effort. Included are abutments to limit oscillations or tilting motions of propeller with respect to power shaft.—2,369,-508, filed Jan. 5, '42, pat. Feb. 13, '45, P. C. A. M. d'Aubarede, vested in Alien Property Custodian.

Novel plane Designs calls for utilizing skid runners for engaging surface of land-

airplane motors run smoothly with

LUBRI-GAS

processed gasoline

Lubri-Gas provides positive lubrication to the upper cylinder parts of airplane motors, reduces friction, eliminates and prevents carbon, frees sticky rings and valves. By lubricating your motor through the fuel with Lubri-Gas you get smooth action and increased performance.

Even should an oil line break, pistons will not freeze and you can land safely under power.

★ ★ ★

"We are operating 35 Piper Cubs on one of the Government Programs and use Lubri-Gas in all this equipment. Lubri-Gas has eliminated sticking valves practically 100%."

Robert F. Shank, President
Hoosier Airport, Inc.

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"We have been using Lubri-Gas regularly and cannot praise it too highly as an airplane gasoline. Since using Lubri-Gas we have not had one stuck valve nor a single top overhaul job except at our regular overhaul periods."

J. W. Hunt, Service Manager
Dayton School of Aviation

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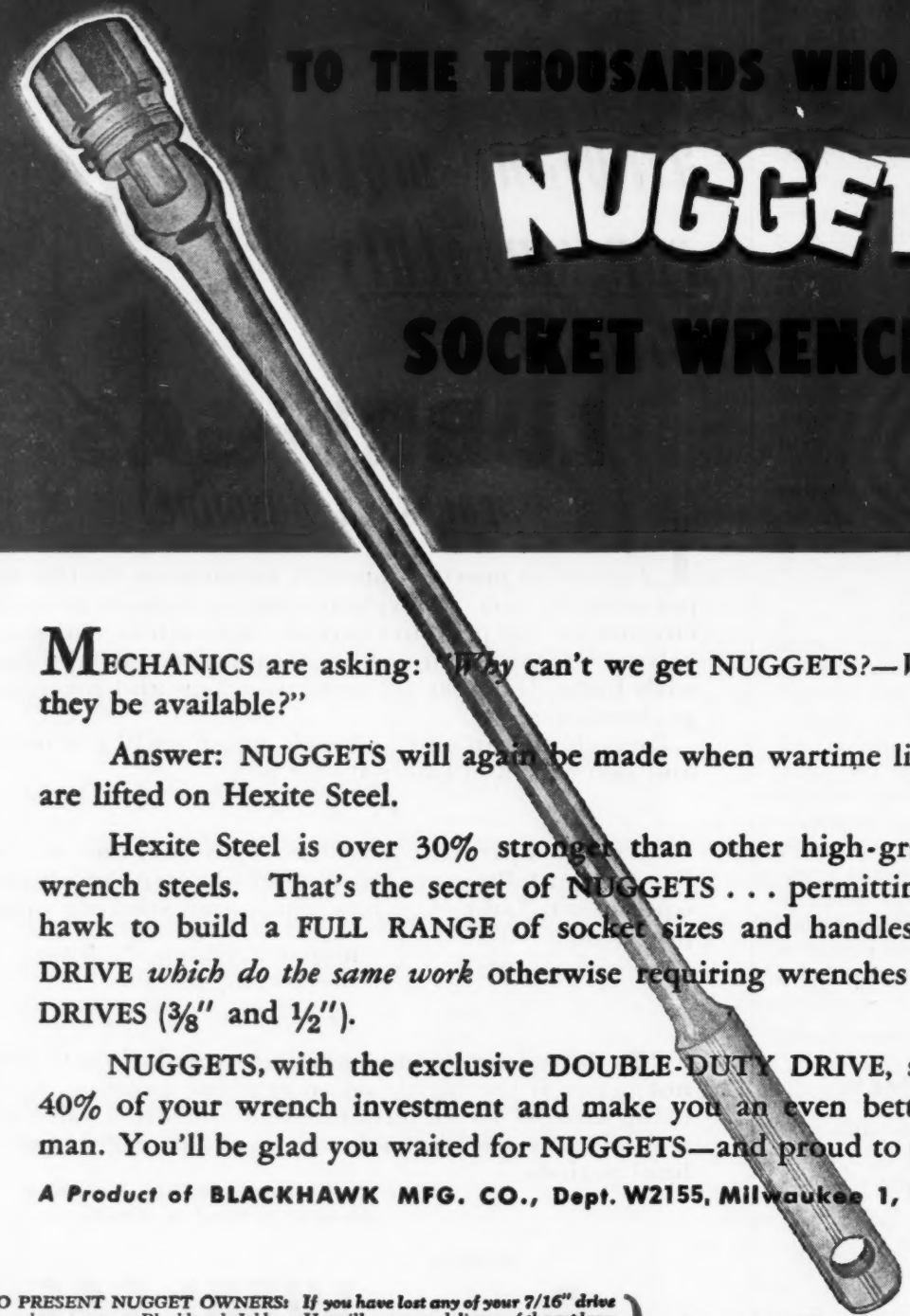
LUBRI-GAS

is Premium Plus because it is not only Anti-Knock, but also Anti-Friction, Anti-Carbon, Anti-Gum, Anti-Sludge.

Cleans and Lubricates as It Powers Your Motor

IMPORTANT

TO THE THOUSANDS WHO WANT NUGGET SOCKET WRENCHES:



MECHANICS are asking: "*Why* can't we get NUGGETS?—*When* will they be available?"

Answer: NUGGETS will again be made when wartime limitations are lifted on Hexite Steel.

Hexite Steel is over 30% stronger than other high-grade alloy wrench steels. That's the secret of NUGGETS . . . permitting Blackhawk to build a FULL RANGE of socket sizes and handles in ONE DRIVE *which do the same work* otherwise requiring wrenches in TWO DRIVES (3/8" and 1/2").

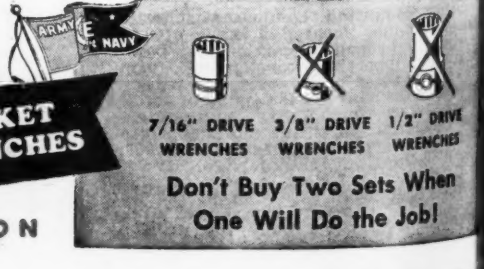
NUGGETS, with the exclusive DOUBLE-DUTY DRIVE, save over 40% of your wrench investment and make you an even better workman. You'll be glad you waited for NUGGETS—and proud to own 'em.

***A Product of* BLACKHAWK MFG. CO., Dept. W2155, Milwaukee 1, Wisconsin**

TO PRESENT NUGGET OWNERS: If you have lost any of your 7/16" drive wrenches, see your Blackhawk Jobber. He will arrange delivery of the replacements. Blackhawk wishes to protect the investment of present owners, even though Nuggets cannot be made and sold on a mass scale to new buyers until after the war.

BLACKHAWK NUGGET SOCKET WRENCHES

THE WRENCHES THAT SMASHED TRADITION



Don't Buy Two Sets When One Will Do the Job!

ing area, tail of plane first being brought in contact with ground to effect skid-stop before forward part of plane contacts ground. Propellers extending beyond wing tips direct airstream across ailerons located at wing extremities, and feathering apparatus consisting of plurality of vanes permits airflow over top and bottom of wing to mix at wing trailing edge without producing eddy currents.—2,369,820, filed Mar. 24, '44, pat. Feb. 20, '45, H. A. Douglas.

Aileron System Design provides for freely floating ailerons located at wing tips, control tabs in associated relation with ailerons, and operating linkages extending between control element and tabs. When control element is in neutral position in upward flight, cams included in operating linkage and being independent of ailerons, automatically control tabs to cause ailerons to float at approximately same angle of attack as wing, between zero angle and stall angle, and thus contribute materially to lift of wing.—2,369,832, filed Dec. 14, '42, pat. Feb. 20, '45, A. J. Klose, assignor, by mesne assignments, to Consolidated Vultee Aircraft Corp.

Airplane Control System is intended to afford change in direction of flight without changing direction in which plane nose and nose guns are pointed, along with means to provide air-resistance braking, counteraction of involuntary side drift, and effect of cross-winds in landing. Invention incorporates rudders positioned above and below engine nacelle and aerodynamic passageways in forward wing structure extending diagonally across wing chord between leading and trailing edges.—2,369,859, filed July 20, '40, pat. Feb. 20, '45, R. G. Sargeant, assignor (one-half) to F. E. Saumenig.

Method of Assemblying fuselages utilizing novel form of jig is designed to simplify fabrication by first fixing some frame elements to supporting device, then establishing second supporting device and fixing frame elements thereto. First supporting device is then removed and covering is applied to framework.—2,370,088, filed Apr. 13, '42, pat. Feb. 20, '45, F. M. Smith, assignor, by mesne assignments, to Consolidated Aircraft Corp.

SENSENICH

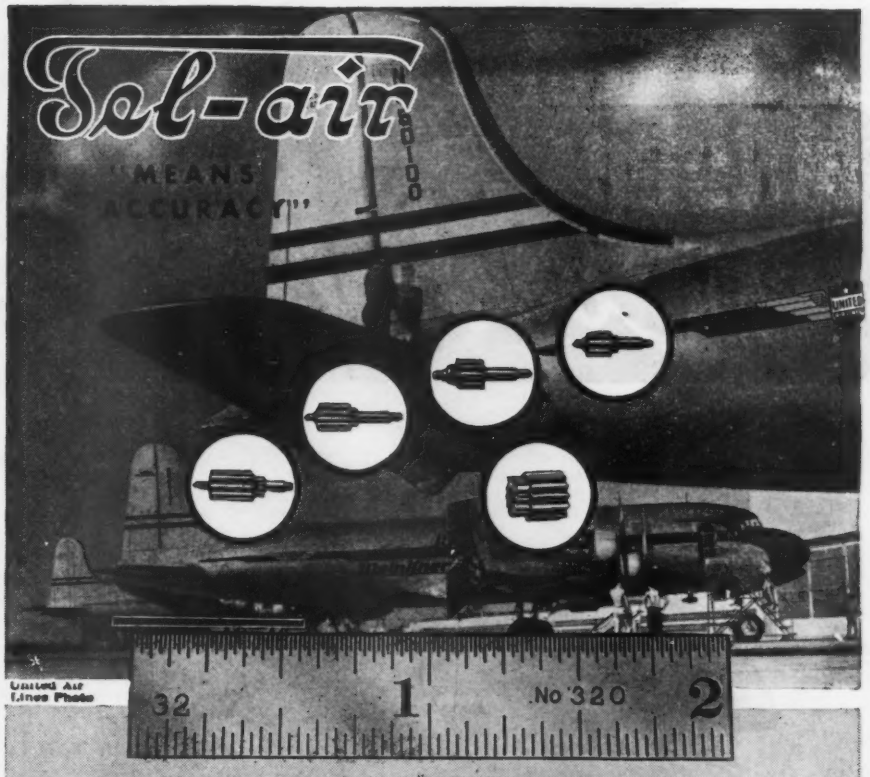
on AERONCA

Approval by factory engineers and test pilots makes Sensenich Propellers *standard equipment* on America's leading airplanes. That is your guarantee of quality and performance. Insist on a Sensenich.

Prompt repair service now available.

AIRCRAFT SENSENICH PROPELLERS

Adjacent to Lancaster Municipal Airport, Lancaster, Pennsylvania—West Coast Branch, Glendale, California



Another Tel-Air Part
Small Tel-Air gears showing comparative size

THE BIG JOB *of the* TINY GEAR

Rule shows how small these little pinions are—yet tiny gears like these have a vital part in the success of a giant machine's operation.

ABSOLUTELY UNIFORM PRECISION, tolerance, and concentricity in every machining and finishing operation — these are essential factors, the perfection of which spells Tel-air ACCURACY.

Bomb Fuzes, in which the pinions illustrated are used, and hundreds of other intricate component parts bear witness to the dependability of Tel-air precision engineering.

Right now ALL Tel-air production is devoted to the final push to end the war as soon as possible.

Buy more War Bonds NOW!

* Planes illustrated are the 4-engine type which United has ordered for post-war service.

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On the Highway it's Teleoptic

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...WITH CURTIS UNIVERSAL JOINTS

Thousands of planes in use today in all parts of the world depend on Curtis Universal Joints to actuate vital mechanisms . . . for engine (gas and spark) rudder, elevator, landing gear or auxiliary power controls.

Where smooth, positive rotation of shafting at angles or around corners is necessary for planes or machine tools, a Curtis Universal Joint in any of 14 "Standard" sizes, or one specially designed to overcome difficult conditions, will more than meet specifications.

Curtis Engineers, with more than 20 years' experience in designing universal joints for many and varied types of installations, are ready to work with you on your present or future plans.

This Flap Stop Valve made by Vard, Inc. Pasadena, California is part of the hydraulic system on a very successful fighter plane. A Curtis Universal Joint is a standard part of this valve unit which controls the circulation of hydraulic fluid.

Write for new Curtis Engineering data and drafting templates . . . both are valuable aids to your designers and draftsmen.

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Whether you turn out fighting equipment for Uncle Sam or are re-tooling for peacetime production, you'll find Chicago Wheels just what you've been looking for to produce better, smoother finishes. The widest range of types, abrasives and bonds — wheels to do any job of grinding so accurately the finish can be measured in micro inches — rubber wheels for polishing or precision cut-off work.

You get the results of half a century of invention, tests and improvements from our modern research laboratory. And, this same laboratory is open to you — tell us about any grinding problem you have and our engineers will tell you how best to whip it.

GRINDING WHEELS up to 3" in diameter in various bonds, including the new FV, the bond with a pedigree.

MOUNTED WHEELS in every practical shape, grain and grade, each firmly mounted on a steel shank.

TRY A TEST WHEEL — Write us what material you have to finish and size wheel you'd like. We'll send one promptly.

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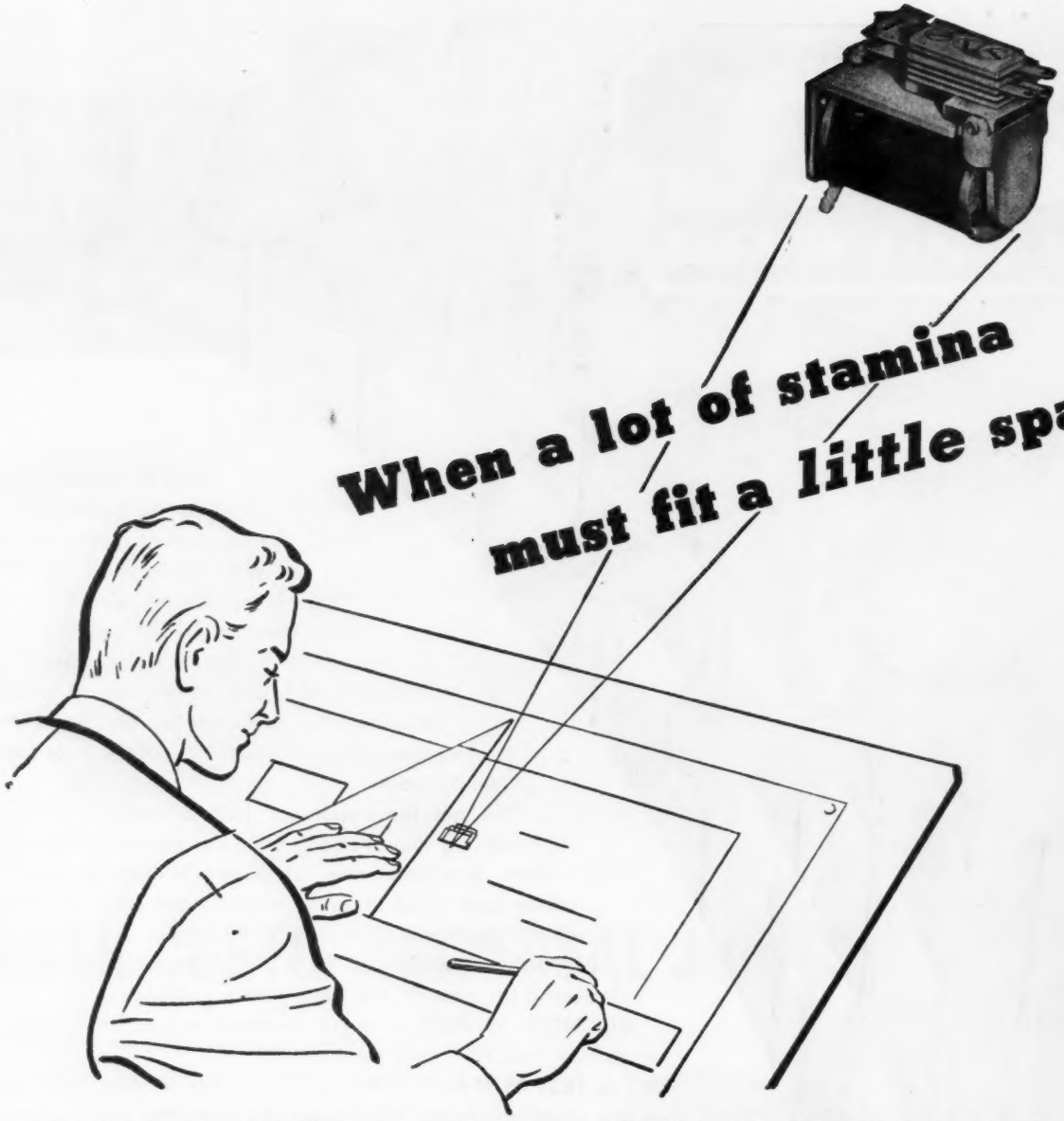

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IF SPACE requirements dictate a small relay —and service conditions a powerful one . . . here's the relay to fit your needs. It's the Automatic Electric Class "S" Relay—tiny in size, light in weight, but dependable and packed with power.

Class "S" Relays have been designed especially to meet the exacting conditions of service on fast, modern aircraft. They offer a combination of features never before found on any relay, large or small. For example:

1. **Vibration-resistance is not just "added on"—it's designed right into Class "S" Relays. And they withstand with a large margin of safety the most rigorous operating tests of the Signal Corps and the Air Forces.**
2. **A unique spring design provides high contact pressure within small space limits.**
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4. **The new type of pin-pivoted armature with full length bearing provides the Class "S" Relay with exceptionally long life even under the toughest conditions.**

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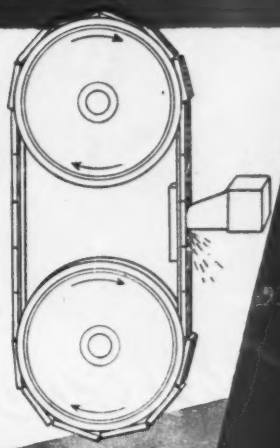

...u can do it on the DoALL Con-...r Machine or on a DoALL Band ...er. Both accommodate the 3/8" ...e Band which finished these ...tal statuettes at the rate of one ...r minute.

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Contour Machine — Thousands are in use today shaping parts used in important war equipment. Although used primarily for internal and external sawing, file bands are included as standard equipment with each DoALL Contour Machine.

Band Filer — For continuous filing here's the best solution — a variable speed precision machine that accommodates work up to 6" thick. The 18" square work table tilts for angle filing. Occupies only 27"x 34" floor space.

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WILL WANT GRIMES LIGHTS
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To our Army and Navy fliers the "GRIMES" insignia is a mark of quality and dependability. When they choose their own plane, they'll want the same lighting equipment that has served them so admirably throughout the war.
In addition to a few of the GRIMES lights illustrated here, there will be many others applicable to the planes now being planned by our foremost aircraft designers. The "Superliner" and the small private plane will be equally served by the experience GRIMES has gained through 15 years of specialization in the design and manufacture of aircraft lights. Superior engineering will continue to bring new lighting standards of safety and convenience with every advancement in aviation.
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If it's Aircraft Lighting...
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GRIMES
Designs and Makes it!

PLAN FOR THE FUTURE

All hands at Southern Aircraft Corporation are working on the components for the Liberator, the Avenger, and the Hellcat. From these same hands has unfolded a plan for the future. While they were working for a quick peace in the world they planned for the peacetime world. Just as soon as Victory is won—SOUTHERN will present their experimental work on one of America's newest types of advanced aircraft.

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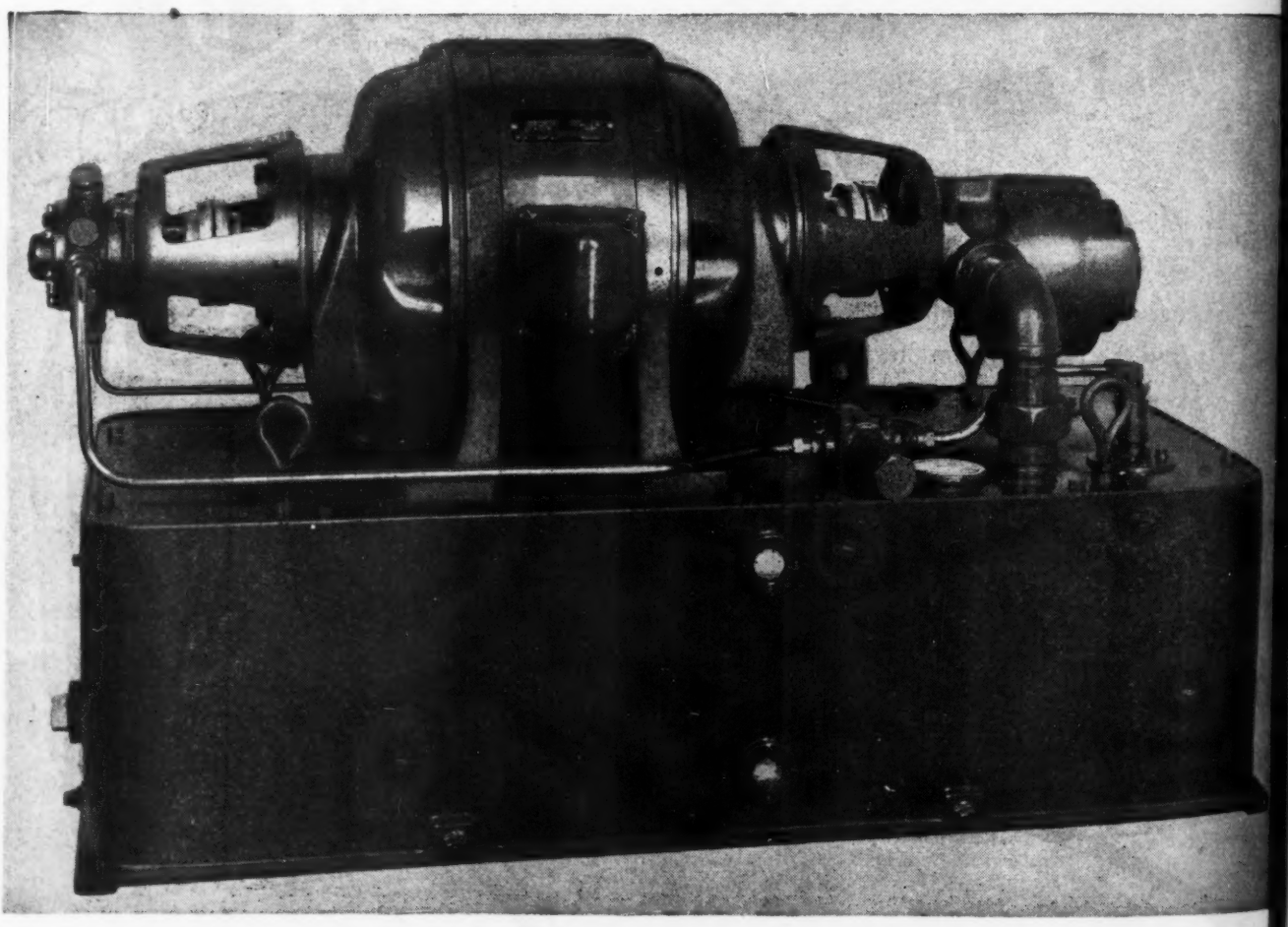
Packaged Units for Fast Prefill
with 3000 p. s. i. Closing and Holding Pressure

Using 10 GPM and 20 GPM Low Pressure Pumps
in Combination with 3/4 GPM and 1 1/2 GPM Pumps at 3000 p. s. i.

Units Complete with Pumps on Double End Motor . . . Unloading and Relief Valves
and Micronic Filter . . . All Mounted on 40 Gal. Water Cooled Reservoir



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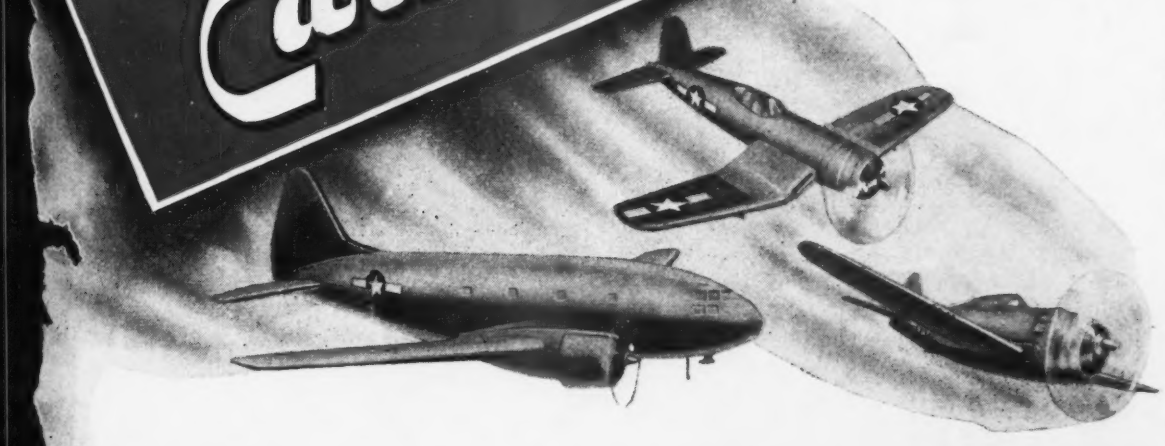
MANUFACTURERS OF HYDRAULIC CONTROLS USED ON THE CORSAIR, P-47 THUNDERBOLT AND THE CURTISS-WRIGHT C-46 COMMANDO TRANSPORT.



May we suggest that you clip this advertisement—now—and place it in your "A.V." (After Victory) files, against the day when your plant program shifts back to peacetime planning.

We shall be amply rewarded if you remember just two words—Carlson Craftsmanship, for it is by this token that you will recall the contribution made to victory in the air by Carlson hydraulic controls.

One hundred percent devoted to the requirements of the armed forces—that is our program, and will be for as long a time as there is any need . . . a continuing record of manufacturing experience and product dependability.

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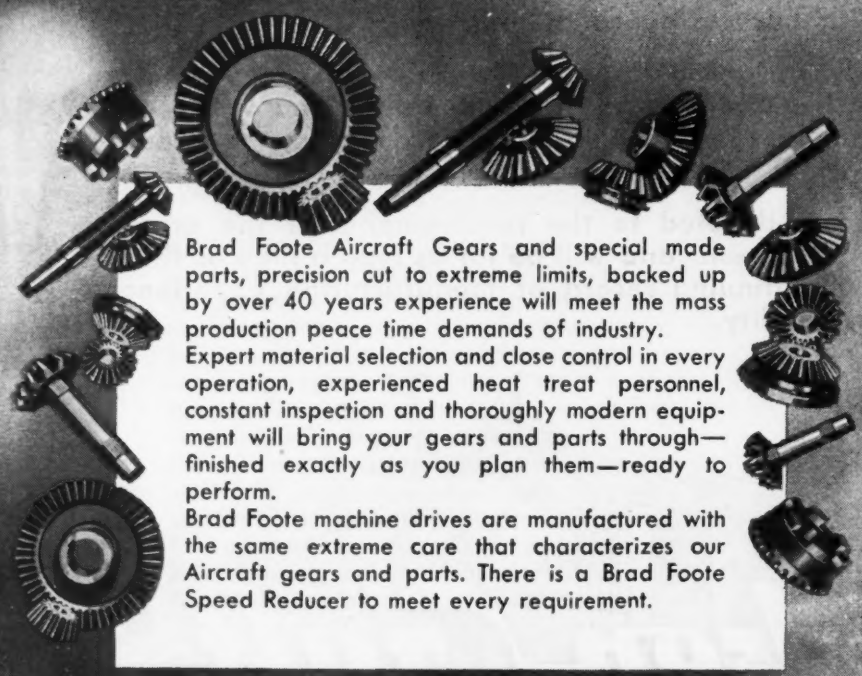
Aircraft



Brad Foote Aircraft Gears and special made parts, precision cut to extreme limits, backed up by over 40 years experience will meet the mass production peace time demands of industry.

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Brad Foote machine drives are manufactured with the same extreme care that characterizes our Aircraft gears and parts. There is a Brad Foote Speed Reducer to meet every requirement.

ARMY E NAVY

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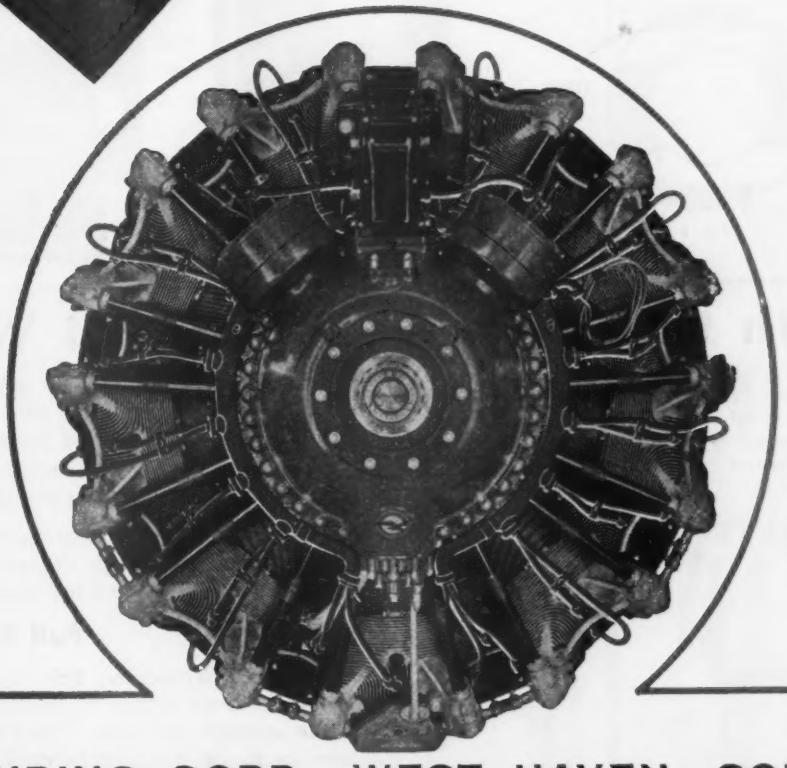

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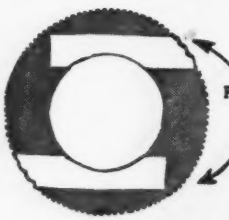


Fig. 1

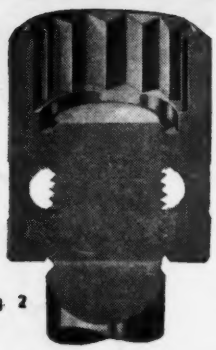
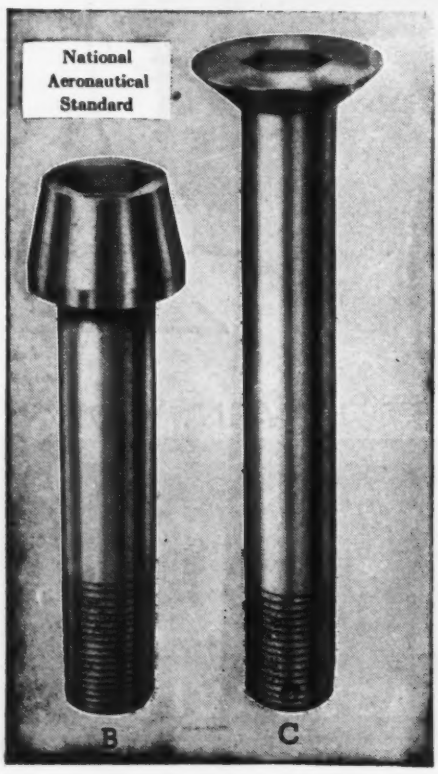


Fig. 2

UNBRAKO

with the "UNBRAKO" Internal Wrenching Lock Nu



For primary connections in aircraft, the "UNBRAKO" Internal Wrenc Lock Nut is a superb and officially approved safety nut. Two vulcan fibre plugs (Fig. 1) inserted through the body of the nut provide the lock feature. Fig. 2 shows how these plugs contact four threads of the b assuring an absolutely dependable locking grip.

This design also permits of maximum thread length in the nut. "Unbra is heat-treated to a high degree of Rockwell hardness and it can be u again and again before the torque falls below the Wright Field Minim

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Our Internal Wrenching Bolt (B) and 100° Flush-Head Socket Bolt (C) f meet the extreme degree of precision, tensile, fatigue and inspection demand by the aircraft industry. They are made to tolerances so microscopic close as to be practicable only by our long and extensive experience precision work and the appreciation of their superior quality is steadily the increase. As a matter of record: The internal wrenching feature bolts "B" and "C" facilitates compact designs—saves weight, space money.

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Crystal-Clear Transparency Affords Maximum Vision

ATEST GLIDER to come off the pro- duction lines of Waco Aircraft the new CG-15A. A large section f the nose is made of transparent u Pont "Lucite" methyl metha- rylate resin. Waco engineers specify Lucite" because of its crystal-clear ansparency, dimensional stability, s outstanding weather-resistance nd its ability to be formed into xtreme contours.

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Limited quantities of "Lucite" are available for experimental purposes, subject to WPB approval. For information, write: E. I. du Pont de Nemours & Co. (Inc.), Plastics Department, Arlington, N. J., or 5801 South Broadway, Los Angeles 3, Calif. *In Canada:* Canadian Industries, Ltd., Box 10, Montreal.

The CG-15A Waco Glider is equipped with nine transparent pieces in the nose and a landing-light cover on the left wing made of "Lucite" as shown in this diagram. Because "Lucite" possesses sufficient rigidity, metal "holding strips" or "frames" for the enclosures are narrower, thus contributing to better vision.

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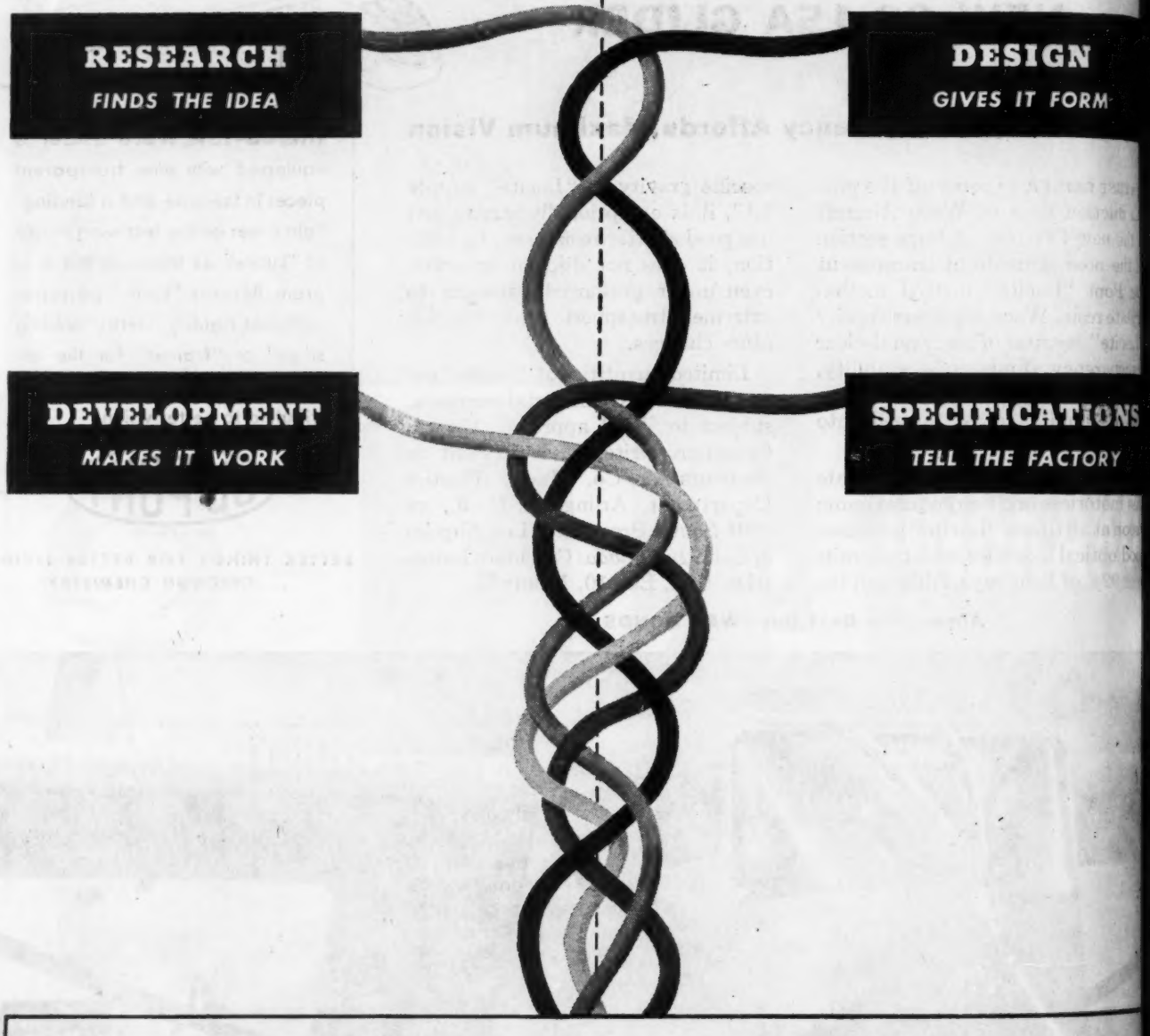

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brings together the efforts of 2000 specialists in telephone and radio communication. Their wartime work has produced more than 1000 projects for the Armed Forces, ranging from carrier telephone systems, packaged for the battle-front, to the electrical gun director which helped shoot down robots above the White Cliffs of Dover. In normal times, Bell Laboratories' work in the Bell System is to insure continuous improvement and economies in telephone service.

TOUGH BABY MADE TOUGHER!

Official U.S. Army Air Forces Photo

"One ack-ack shell made a direct hit on one of the Invaders. An armament expert told me that the shell ordinarily would have penetrated an ordinary airplane, but on the A-26, it hit the armor plating and left only a scratch about an eighth of an inch deep and eight inches long."

The Invaders have been used

TODAY:

R301 is Reynolds great armor plate alloy

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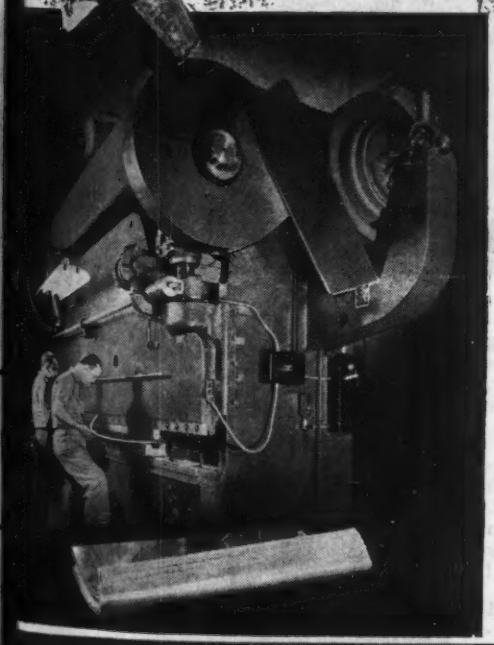
R301 is Reynolds great sheet and plate alloy, for high strength, toughness and easy workability



HERE is a metallurgical triumph . . . an aluminum alloy so strong and resilient that it sheds flak . . . so light that it can be used to armor plate a fighting bomber like the A-26.

Adding toughness to the A-26 is a proud accomplishment, yet it is only one of many jobs R301 is doing for the fighting forces.

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R301 today leads the field in usefulness . . . reward for the pioneering spirit which distinguishes Reynolds and Reynolds engineers.

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See Reynolds catalog in Sweet's; also write for special bulletins on R301 and other Reynolds light-weight, high strength aluminum alloys. Reynolds Metals Co., Aluminum Div., 2536 S. 3rd St., Louisville 1, Ky.

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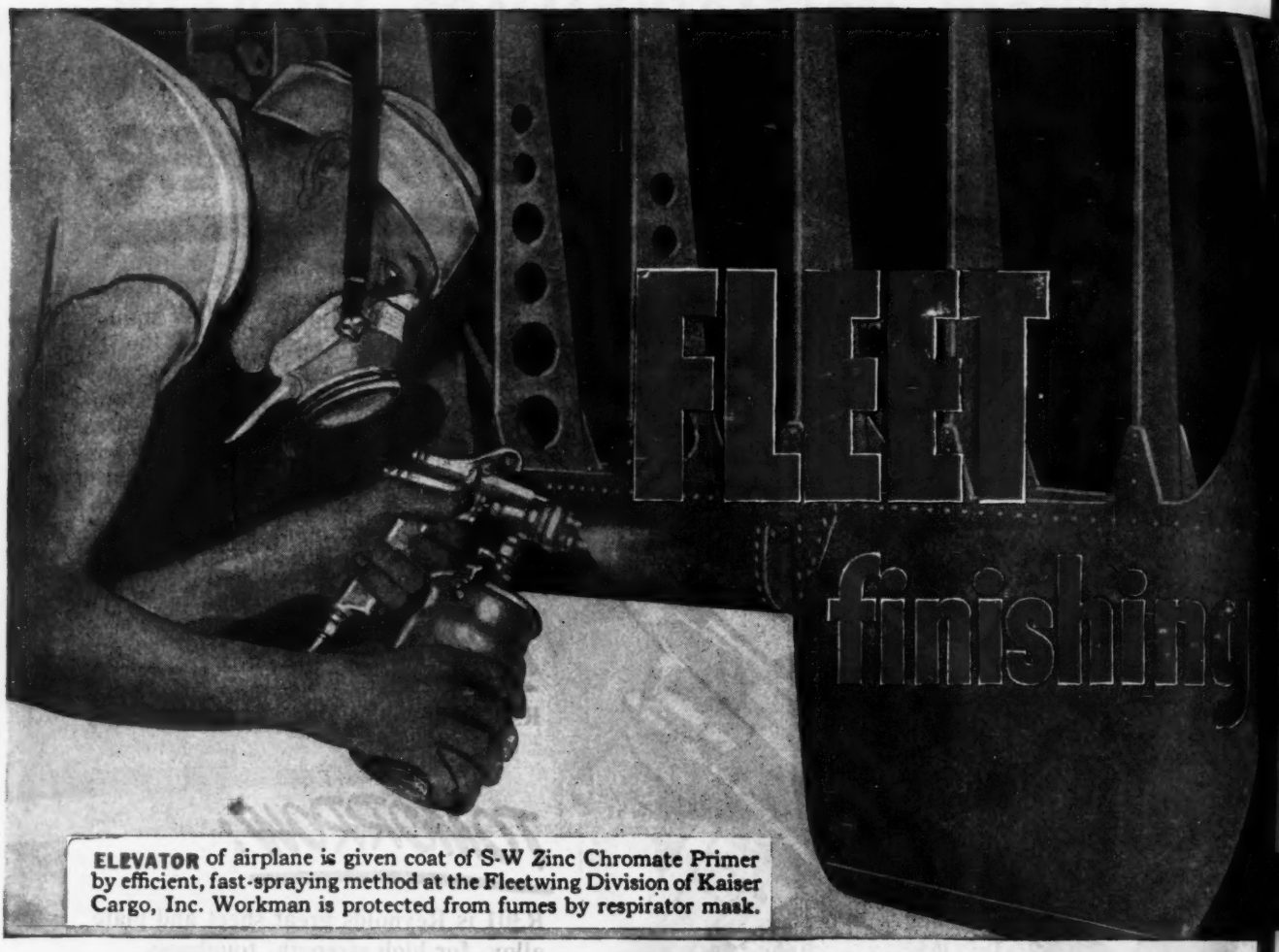
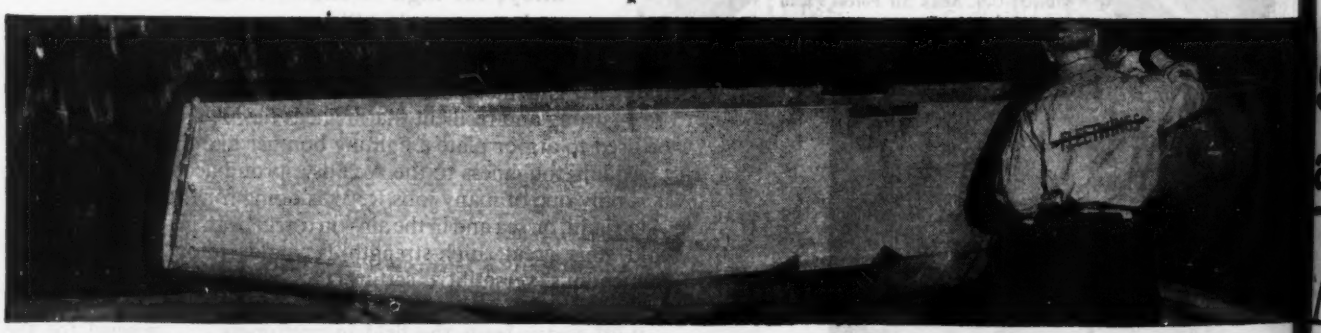
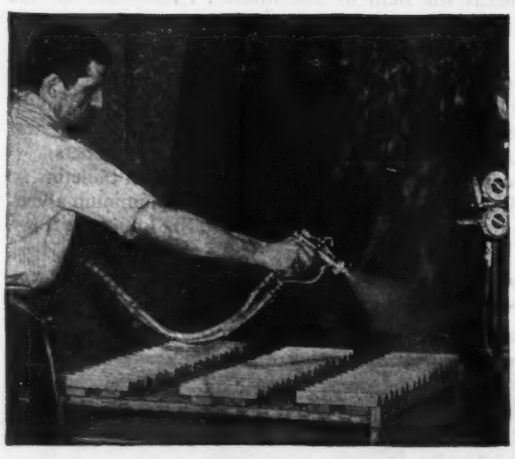


ELEVATOR of airplane is given coat of S-W Zinc Chromate Primer by efficient, fast-spraying method at the Fleetwing Division of Kaiser Cargo, Inc. Workman is protected from fumes by respirator mask.





EFFICIENT method of conveyor-hanging makes spraying easier. When finished, aileron is pulled up to ceiling to dry, thus saving valuable floor space!

ANGLES used in wing construction are sprayed with S-W Zinc Chromate Primer. Vacuum exhaust in modern finishing booth sucks away surplus paint, speeds drying!

STABILIZER is being sprayed with S-W Sea Blue Gloss Lacquer. Here again, vacuum exhaust and special lights simplify operation and speed production. →

SHERWIN-WILLIAMS

[All photos courtesy of Kaiser Cargo, Inc., Fleetwing Division]

SHERWIN-WILLIAMS Helps Speed Production at KAISER CARGO, INC., FLEETWING DIVISION!

AT the Bristol, Pa., Fleetwing Division of Kaiser Cargo, Inc., airplane wings and control surfaces fly off production lines in typical "Kaiser" fashion... are soon part of famous Douglas, Boeing, Grumman, Chance Vought, Lockheed, Eastern Aircraft and other planes!

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*Among these services is the S-W perfected Thermotite doping system which is effecting revolutionary savings in time and labor. (THERMOTITE trade-mark Reg. U. S. Pat. Off.)

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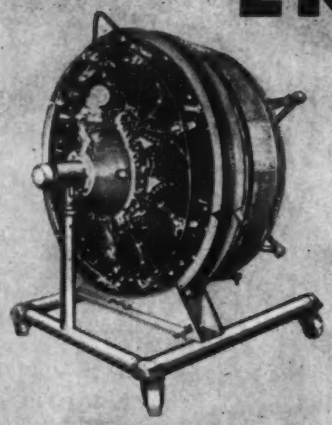
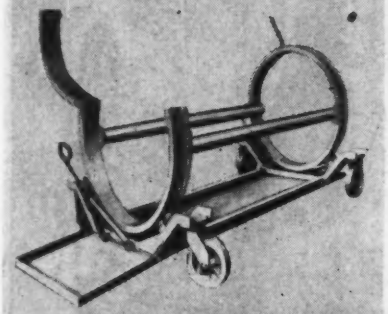
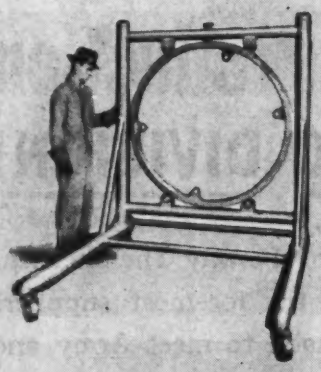


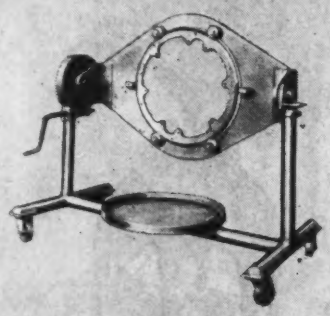
THE WHITING TYPE "RA" UNIT



THE WHITING MODEL E-3
ENGINE ASSEMBLY STAND



THE WHITING MODEL N
ROTATABLE NACELLE BUILT-UP UNIT



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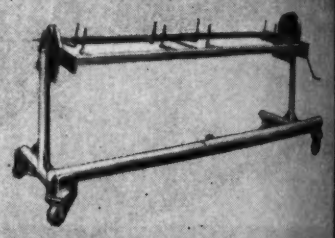

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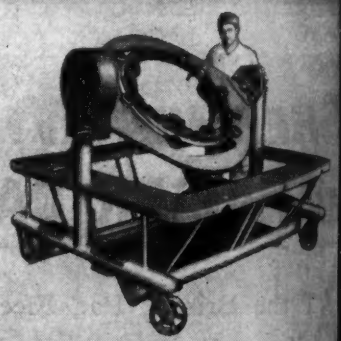
MULTI-PURPOSE ENGINE STAND



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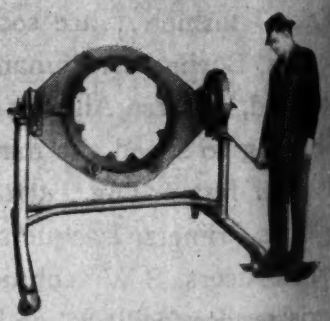

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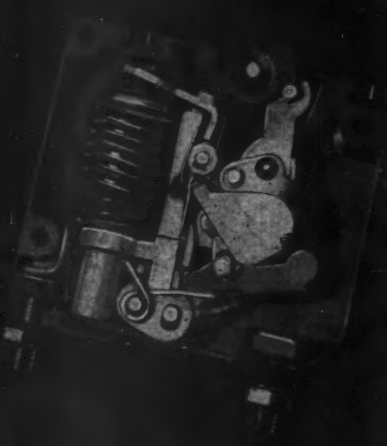
They have the GUTS to Keep 'em Flying... Fighting... Firing...



Short circuits and dangerous overloads open the breakers instantly while trip is delayed on momentary, harmless overloads. They are vibration proof and shock resisting.

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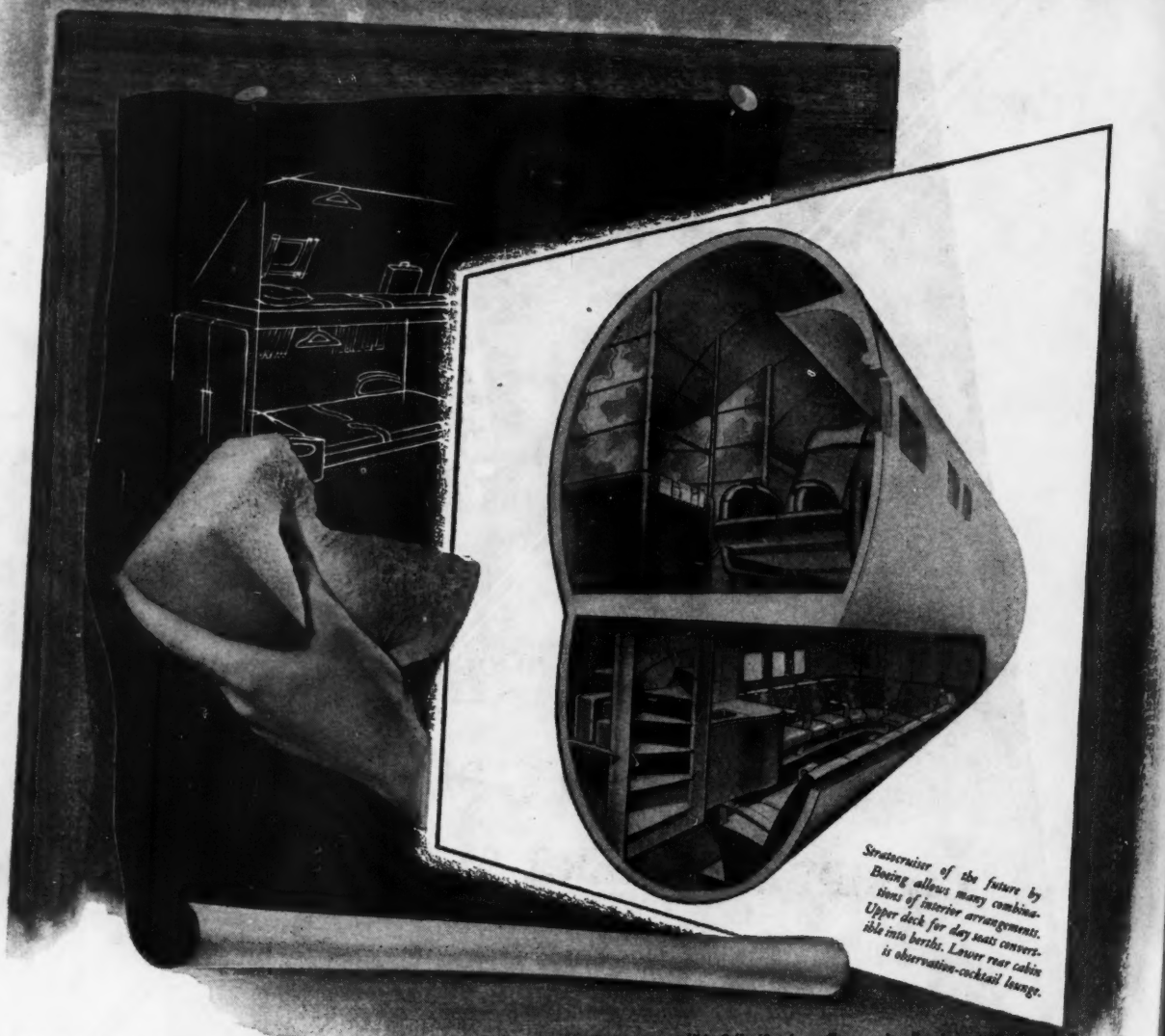

Stratocruiser of the future by Boeing allows many combinations of interior arrangements. Upper deck for day seats convertible into berths. Lower rear cabin is observation-cocktail lounge.

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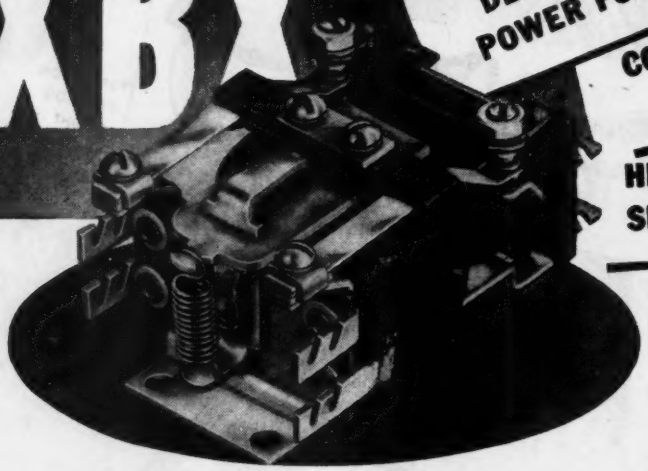

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These relays are light, small, and sturdy. Highly electrically efficient, they deliver a lot of power for their size. Contact pressures up to 50 grams are available. Bakelite insulation is supplied for power circuit applications, and ceramic insulation for radio-frequency use. A-C coils to 115v, 60 cycles; or d-c coils to 115v are available. Contacts may be in any desired combination up to and including 3 pole, double throw. All 10XBX relays withstand 10G vibration and are highly resistant to shock. Other relays of the 10-frame series are available in either single or three pole contact arrangements.

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Enlargement of an actual photograph of an A-N Connector sawed in two. Note closeness and accuracy of fit, elimination of leakage.
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To Conduct 1 to 46 Circuits
Like Continuous Wire . . . . Yet
Provides for a Quick Disconnect
AMPHENOL

Today complex electrical circuits and operating units in planes can be disconnected and reconnected in a few seconds time. Interchangeable operating units can be replaced quickly.

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Connectors (A-N, British, U.H.F.), Fittings, Cable Assemblies, Conduit, U.H.F. Cable, Radio Parts, Synthetics for Industry

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Millions of ball bearings are protected from the ingress of dirt, grit and moisture, or the leakage of oil and grease lubricants by means of Felt seals. Felt pistons for grease guns and self-filling fountain pens, glass pipe gaskets weatherstripping, and drive shaft housing seals typify the variety of Felt sealing applications.

In aviation, Felt is used for bomb bay door gaskets and to seal transparent nose cones.

Felt seals, gaskets, and retainers are *cut to close order* tolerances. Our facilities for mass production assure prompt delivery. Laboratory control assures uniformity on re-orders.

American Felt Company product engineers are available to discuss the latest techniques in Felt sealing — or to advise on any other Felt application. Write for Data Sheet #11, "Annular Designing and Dimensioning."

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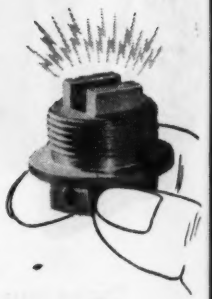
DANGER! WARNS THE SIREN

—And LISLE PLUGS warn in advance of DANGER! to aircraft engines



The occurrence of dangerous hidden wear in aircraft engines immediately produces metal particles which circulate in the lubricant. Lisle Magnetic Drain Plugs bring this condition to light at once. They capture the ferrous metal cuttings by means of a powerful magnet anchored in the Plug. Regular inspection of the Lisle Plug reveals these abrasive particles promptly—uncovers hidden danger *before* serious trouble can occur. As a result, repairs or replacements can be made BEFORE a serious breakdown occurs.

DESIGNERS: For greater safety margin, specify Lisle Plugs instead of ordinary drain plugs. Write today for free sample Plug and engineering data. No obligation.

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Light Weight MAGNETIC CONTACTORS by GUARDIAN...

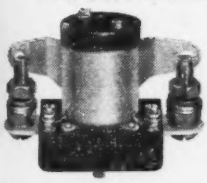
Built to Army and Navy Specifications

☆ Lighter weight . . . and more efficient performance. These are the chief advantages of Guardian Magnetic Contactors. The types shown below are now being used in Army & Navy aircraft circuits for control of starting motors, bomb bay doors, landing lights, wing flaps, etc. They are tested to operate in all positions under accelerations exceeding ten times gravity at altitudes up to 50,000 feet and under extremes of temperature and humidity. All moving parts are enclosed and protected from dust and injury. Entire units may be disassembled with only a screwdriver and pliers. Mention quantity when writing for prices and delivery information.

ARMY TYPES

A.A.F. TYPE B-4

Spec. No. 94-32324



Unusually light in weight, this type of B-4 with its auxiliary switch, is at the same time more efficient. It has a double wound coil and is designed for *continuous* duty.

Contact rating: 200 amps. continuous • Voltage: 24 volts D.C. • Minimum attract voltage: 18 volts D.C. • Weight: 20.5 oz.

A.A.F. TYPE B-5-B

Spec. No. 94-32351

Smaller contacts, rated at 50 amperes, and simplicity in design make this the lightest of magnetic contactors. Contacts will handle current surges in excess of 200 amperes. Designed for continuous duty.

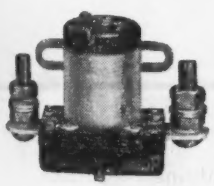
Contact rating: 50 amps. continuous • Voltage: 24 volts D.C. • Minimum attract voltage: 18 volts D.C. • Weight: 11.2 oz.

A.A.F. TYPE B-6-B

Spec. No. 94-32352

A.A.F. TYPE B-7-B

Spec. No. 94-32353

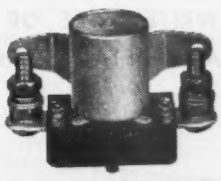


These two types are essentially the same as the B-4 except for rating of contacts in construction and mounting bracket. They differ from each other in mounting bracket and size of terminal posts. B-6-B has ¼" terminal posts: B-7-B has ⅜" posts.

Contact rating: 100 amps. continuous • Voltage: 24 volts D.C. • Minimum attract voltage: 18 volts D.C. • Weight: (B-6-B) 20 oz. (B-7-B) 21 oz.

A.A.F. TYPE B-8

Spec. No. 32424



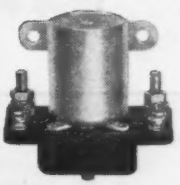
Specifically designed for *intermittent* duty in engine starter circuits, etc. Contacts withstand current surges up to 1200 amperes without welding. Coil drops out at 3 volts; consumes a maximum of 4 amperes at 24 volts D.C.

Contact rating: 200 amps. continuous • Voltage: 24 volts D.C. • Minimum attract voltage: 7 volts D.C. • Weight: 22.5 oz.

NAVY TYPES

N.A.F. TYPE 1204-1

Spec. No. M-569a
Catalog No. G-34987

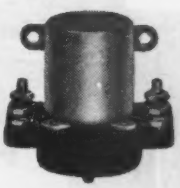


The smallest and lightest of the Navy types with contacts rated at 50 amperes. Coil draws 220 milliamps at 24 volts D.C. Designed for continuous duty. Coil drops out when voltage has been reduced to less 7 volts.

Contact rating: 50 amps. continuous • Voltage range: 18-28 volts D.C. Weight: 11.2 oz.

N.A.F. TYPE 1204-2

Spec. No. M-569a
Catalog No. G-35792

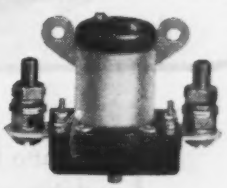


Another continuous duty contactor designed to Navy specifications with contacts rated at 100 amperes continuous. Release voltage is less than 7 volts D.C. Sealing voltage is 14 volts D.C. with contacts closed manually.

Contact rating: 50 amps. continuous • Voltage range: 18-28 volts D.C. Weight: 19 oz.

N.A.F. TYPE 1204-3

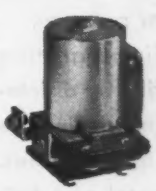
Spec. No. M-569a
Catalog No. G-34989-A



Has a double wound coil drawing 2.2 amperes on attract at 18 volts D.C. and 220 milliamps when auxiliary switch cuts in a higher resistance. Designed for continuous duty.

Contact rating: 200 amps. continuous • Voltage range: 18-28 volts D.C. Weight: 20 oz.

GUARDIAN TYPE SC-5



For electric motor control in gun turrets, motor generator sets, landing lights, landing gear, wing flap, cowl motors. For dynamic braking of D.C. motors up to 1 H.P. Contact rating: 75 amps. continuous. Voltage: Coil operates on 18-28 volts D.C. Minimum attract voltage: 18 volts D.C. Contact combinations: SPST normally open, double break—SPST double break—2P, one normally open, one normally closed, double break. Weight: SPST 16 oz.—SPDT 19 oz.

GUARDIAN ELECTRIC

1614-F W. WALNUT STREET CHICAGO 12, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN WAR INDUSTRY

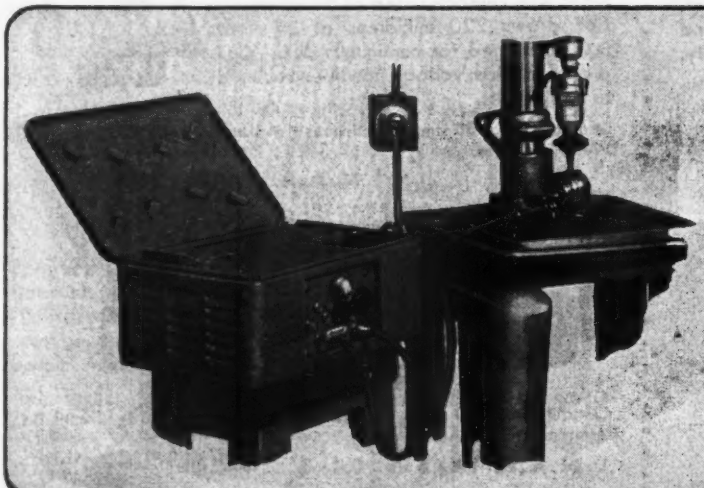
In six crucial hours

Drafto Metal Disintegrator saves two $1500.00 crankshafts

Two badly needed crankshafts each had a broken quarter inch drill embedded in an oil hole five inches below the surface. Cancellation was imminent.

Drafto rushed special length electrodes. Set-up and disintegration time for the first drill was four and one-half hours. The second drill was disintegrated in an hour and one-half. Both jobs passed government inspection.

Estimated saving, $3,000. Also important, the badly needed shafts were completed and shipped in a few hours.



Typical set-up using drill press. Disintegrator "head" chucked solidly in locked press; work piece clamped firmly to table. Disintegrator may be set up to operate at any angle. "Head" does not rotate.

THE Drafto Metal Disintegrator is a compact, portable, self-contained unit designed to save dies and work pieces you formerly scrapped because of embedded tools. It disintegrates metal through the action of a rapidly vibrating electric arc, without excess heat or pressure.

Broken taps are removed by disintegrating the core. You take out broken drills by disintegrating the web. Studs and hardened pins are removed by disintegrating odd shaped holes.

Finished surfaces, hardness of metal, and delicate contours are not affected, for disintegration takes place only where the electrode touches.

Drafto Metal Disintegrator requires no lengthy training period. It comes to you complete, ready to go to work, with its self-contained coolant tank and pump, and a supply of electrodes for $295. Manufactured by Drafto Corporation, Cochranton, Pa. Representatives in key cities.

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SPARK PLUGS

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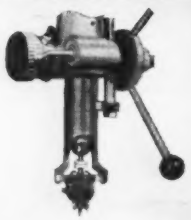
This tool will speed your work and cut your costs



Used With All Standard Nutplates

Four Standard Sizes

Model	A	B
ZT23	.690	.345
ZT125	.750	.375
ZT24	1.000	.500
ZT126	1.375	.687

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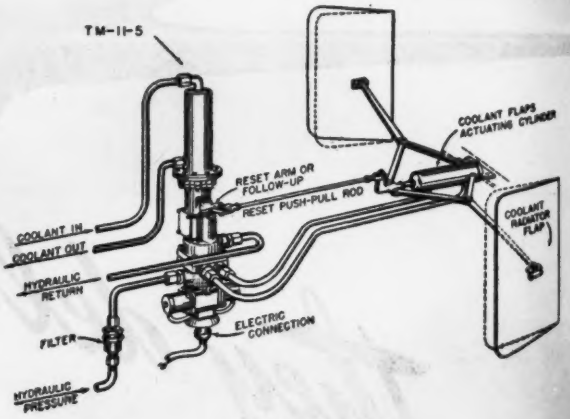
Engine Coolant Temperature Control

By

GENERAL CONTROLS

The TM-11-5 is specifically designed to assure the precise limits of engine coolant temperature control, necessary for maximum engine efficiency.



A four-way hydraulic Selector Valve is directly operated by a temperature reactant Bulb Assembly, the sensitive portion of which is immersed in the coolant. Thus, the position of the exit flaps is automatically controlled in accordance with varying coolant temperature requirements. Engine temperature is maintained at maximum operating efficiency and wide temperature fluctuation is eliminated.

Authorized Users are invited to write for complete engineering data.

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WHAT ARE YOU GOING TO DO ABOUT THE NEW ALLOCATIONS?

HERE'S ONE THING YOU CAN DO ABOUT THEM NOW.

Perhaps by the time you read this, all frequency allocations will have been pretty well settled. You'll be thinking about how your present equipment will fit into the future.

Browning Laboratories have always designed and manufactured soundly engineered and ruggedly built equipment for specific services. Right now every available manhour goes into design and manufacture for the Armed Forces. But, looking ahead, if you'd like Browning to have a converter for your specific needs, tell us how you'd like it.

This applies to both AM and FM receiving equipment. Tear out this page now, as a reminder, or write us a letter.

BROWNING
LABORATORIES, INCORPORATED
WINCHESTER, MASSACHUSETTS

HERE IS A HANDY FORM TO HELP YOU see where you stand. If you mail it to Browning Laboratories, it will give you an opportunity to say exactly what you want by way of conversion equipment.

Browning Laboratories, Inc.
750 Main Street
Winchester, Mass.

Gentlemen:

My present AM receiving equipment has ranges of ..... to ....., ... to ....., ... to ....., ... to ....., ... to ....., ... to ....., ... to ....., ... to ....., ... to .....

☐ **It will be satisfactory in the new allocations without a converter.**

It will have to be converted to ranges of ..... to ....., ... to ....., ... to ....., ... to ....., ... to ....., ... to ....., ... to ....., ... to ....., ... to .....

My present FM receiving equipment has ranges of ..... to ....., ... to ....., ... to ....., ... to ....., ... to ....., ... to ....., ... to ....., ... to ....., ... to .....

☐ **It will be satisfactory in the new allocations without a converter.**

It will have to be converted to ranges of ..... to ....., ... to ....., ... to ....., ... to ....., ... to ....., ... to ....., ... to ....., ... to ....., ... to .....

If a dependable Browning Laboratories converter is available, here are the special features it should have to be most useful to me:

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Dressed to fight ic

2 EMPENNAGE DE-ICERS work positively and efficiently giving horizontal stabilizers and fin complete ice protection. Small-diameter light aluminum tubing carries air pressure back to De-Icer tube openings.

3 ANTENNA MASTS can be protected against ice build-up by easily installed tube-type De-Icers. Electrical anti-icers employing conductive rubber are in the development stage for this application.

1 WING DE-ICERS have been steadily improved since their introduction in 1930. The latest type is the best ice-protection device ever developed for aircraft. The entire critical leading edge area is protected—chordwise and spanwise—with operation just as efficient at the wing tips as near the fuselage. De-Icers present no structural hazards and they represent only a fractional percentage of a commercial plane's gross weight.

4 PROPELLERS can be protected two ways. B. F. Goodrich makes both feed shoes (which utilize anti-freeze fluid) and conductive rubber shoes (electrically heated).

5 SPINNER DOMES need anti-icers, too. Electrically heated conductive rubber caps may be the answer, and B. F. Goodrich development work is under way.

ct all critical points...

Only B. F. Goodrich offers this *complete* ice protection

EVERY unprotected leading edge surface that bites into icing conditions can and does pick up its load of ice. Wings, empennage, propellers, spinner domes, antenna masts and housings, direction finders . . . all need ice protection for maximum safety and efficiency. And B. F. Goodrich makes the equipment to do the job.

For wing and tail leading edges, the B. F. Goodrich rubber De-Icer is the best protection device ever developed. De-Icers guard *all* critical surfaces. They operate just as positively *at the wing tips* (where stall is most critical) as near the fuselage. These tube-type De-Icers also effectively protect pitot and antenna masts and other protruding accessories.

Tube inflation selectivity, variable inflation sequences, and instantaneous inflation and deflation, secured to recently developed operating equipment, improve the effectiveness and efficiency of the De-Icer system.

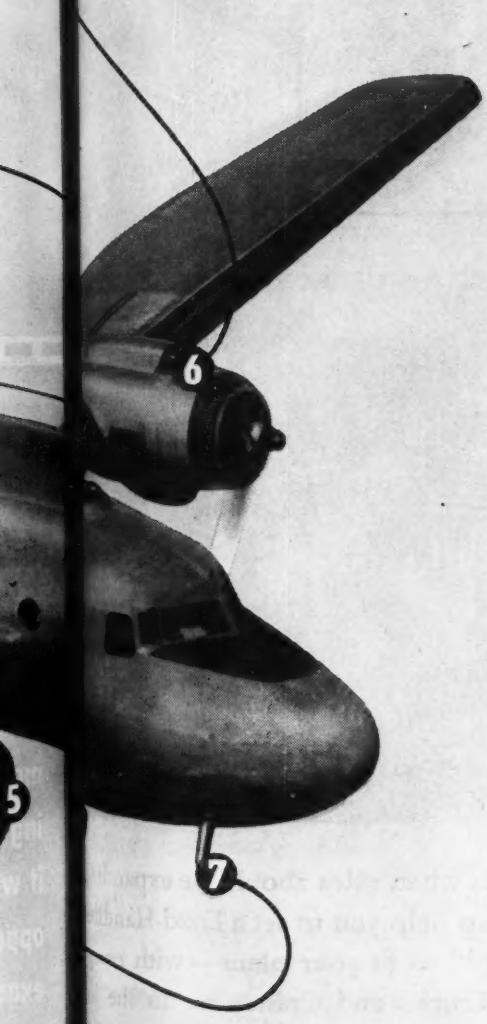
B. F. Goodrich offers *two* excellent ways to protect propellers. Best known are the rubber feed shoes which guide anti-freeze fluid out along edges to keep ice from forming. A more recent development is the heated propeller shoe.

Like the feed shoe, it is attached to the blade leading edge, but it operates on electricity from a hub generator or other source of electrical energy. This current flows out through electrodes on both sides of the shoe and across the icing surfaces through specially compounded conductive rubber. Carefully designed resistances concentrate heat directly at the leading edges where most ice forms.

More electrical anti-icer developments are on the way. Successful tests have already been completed on the cowl ring air intakes of a large bomber. Other suggested applications are masts, fuselage nose, spinners and struts. You'll probably be hearing more about these in the near future.

Perhaps you have a problem that over twenty years' ice-fighting experience will solve. If so, get in touch with "headquarters"... The B. F. Goodrich Company, Aeronautical Division, Dept. A-5, Akron, Ohio.

6 **COWL RING** air intakes can be protected with electrical anti-icers using special conductive rubber. Tests recently completed on a larger bomber proved this type installation practical.



PITOT MASTS can be fitted with easily installed rubber De-Icers operating on the regular air system. Tests are being made on an electric anti-icer for this application.

DIRECTION FINDER is another accessory that suggests the electrical anti-icer treatment.

ALL PROTRUDING accessories can be equipped for ice-protection. De-Icers are already available for sea-wings, pontoons, wing slots and struts. And electrical anti-icers may prove even a better answer to accessory icing.

All made by B. F. Goodrich . . . **Fuel Cells (self-sealing and non-sealing bladder type) . . . Fuel and Hydraulic Hose . . . Extruded Parts . . . Grommets . . . Airplane Tires . . . Expander Tubes for brakes . . . Rivnuts.**

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Maybe your Business needs a new "Load-Handling Pattern"

. . . the E-P Man will help you to set it!

You *do* need a Load-Handling Pattern—

if you use Power Industrial Trucks in some of your manufacturing operations but not in all 7 shown above;

if your materials go through production in dribs;

if you tolerate aimless picking-up and setting down of loads in process;

if you scatter them over costly floor space but leave a vacuum overhead; or

if some departments monopolize the Trucks you have, leaving other departments "hungry".

Wasteful transportation multiplies costs—increases the price that customers must pay—limits sales when sales should be expanding. The E-P Man can help you to set a Load-Handling Pattern "tailored" to fit your plant—with *enough* Elwell-Parker Trucks and Cranes to do the job at a real profit to you.

Better dial him now, or write us. The Elwell-Parker Electric Co., 4125 St. Clair Ave., Cleveland 14, Ohio

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MONTHS OF underfire plane maintenance on the Pacific Islands or on airfields behind the lines of the Western Front—that's the kind of service you don't forget! And that's the story of the Army and Navy ground crews working with Airwing Aviation Fabrics and Tapes to help keep them flying.

After victory, the same partnership that made speedy, durable repairs on fighting air strips around the world will serve the flying public at airports from coast-to-coast.

The Airwing line includes airplane and glider fabrics, balloon and special cloths. Airwing Tapes come in a complete selection—Grade A made from long staple Pima cotton, and Lightweight—pinked edge, sealedge, biased, and pre-doped.

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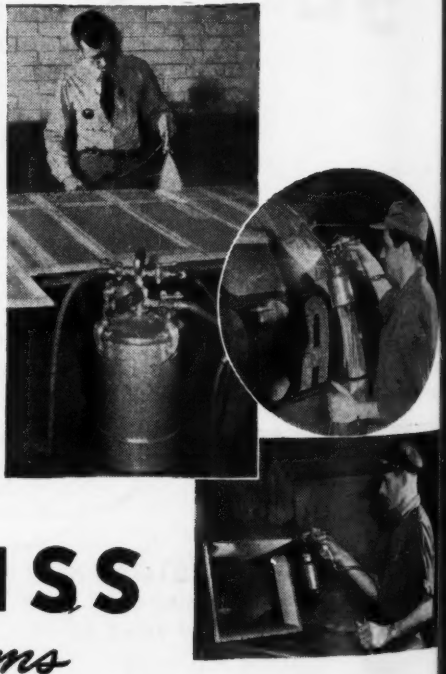
THE nation's leading airlines are using DeVilbiss Equipment to put their service operations "on the beam" and to be sure of faster, more efficient work.

PCA—with far-reaching routes East of the Mississippi—is one of them. Their DeVilbiss Equipment helped set new PCA records last year in passengers, mail and express flown—by the fast conditioning of planes between flights.

Three types of work their DeVilbiss Equipment performs are shown here—doping fabric wing sections—applying a transparent seal over newly-painted insignia—painting small parts.

Over the Nation's great airline network DeVilbiss Equipment is also used in degreasing engine parts, caulking seams, painting complete planes, compressing air for shop tools, ventilating paint shop areas.

DeVilbiss' experience in producing air-using, air-handling equipment can help you. Ask your aviation supply distributor or write the factory.



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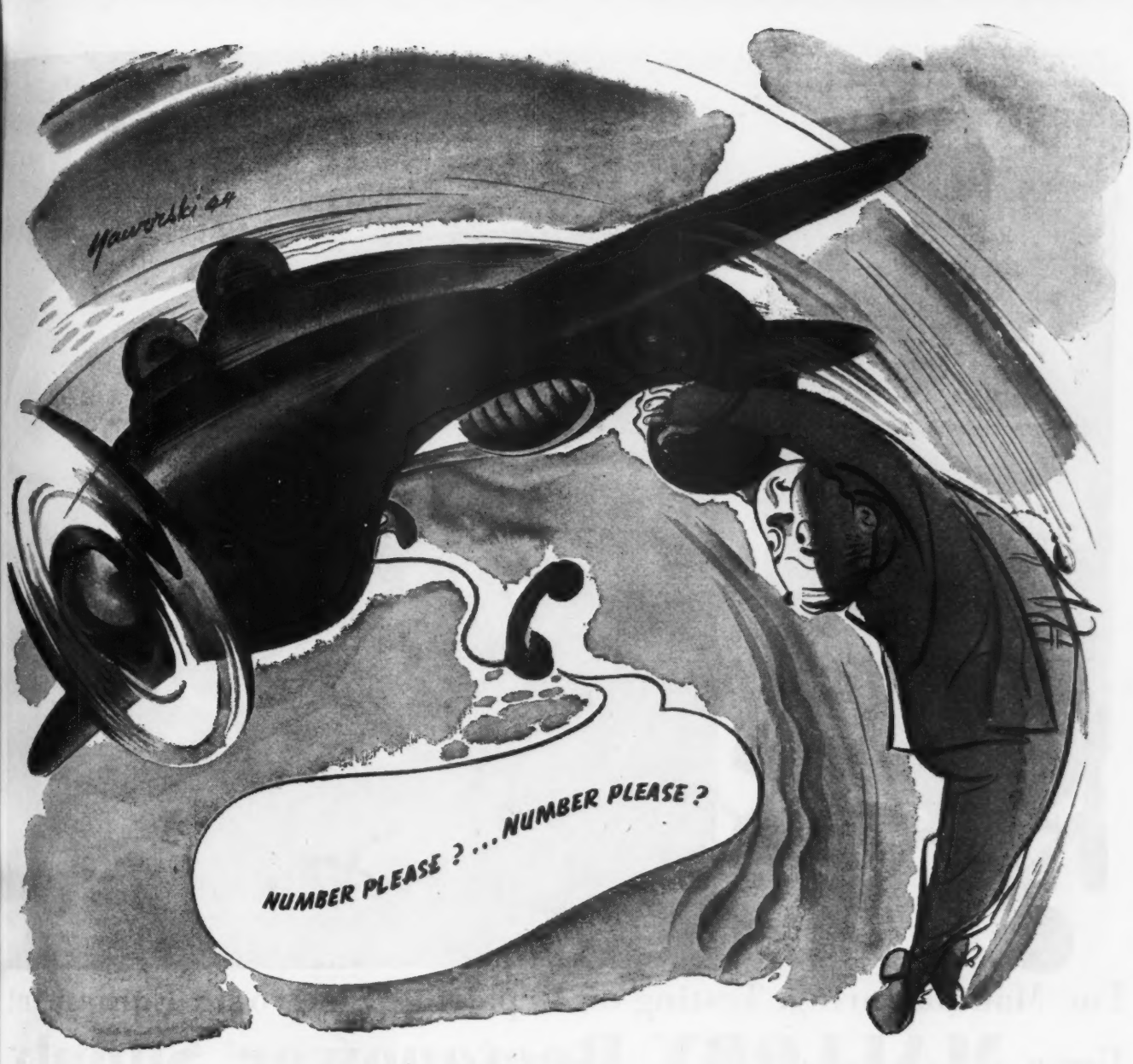
SPRAY EQUIPMENT • EXHAUST SYSTEMS • AIR COMPRESSORS • HOSE & CONNECTIONS



. . . RADIO TO KEEP YOU FLYING SAFELY

Radio to keep you flying safely is going to be one of the prime requisites in that postwar plane of yours. Hallicrafters, busy now with the production of all kinds of communication equipment for war, will have interesting plans for peace time aviation radio. When in days to come the airport operator inquires "Number please?" here's hoping you'll be able to answer her on the Skyfone—marked with the name of Hallicrafters, a symbol of radio sensitivity, selectivity, and dependability under all conditions.

Skyfone

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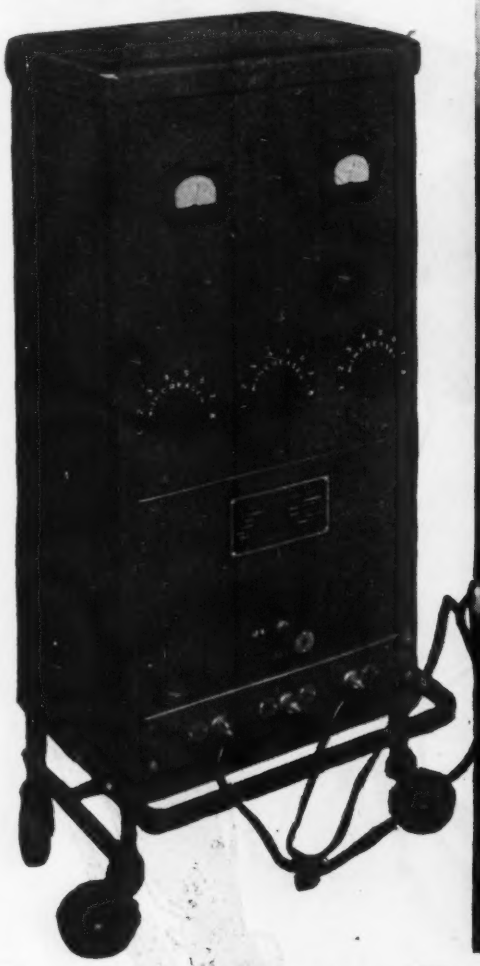
Checking an Ultra High Frequency aircraft receiver with a special testing unit at the Civil Aeronautics Administration Experimental Station. Dependable DC power is provided by this mobile Mallory Rectopower Supply, which can also be used to charge batteries.



For Manufacturing, Testing or Repairing Electronic Equipment Use a MALLORY Rectopower† Supply

AT THE CAA Experimental Station, Weir Cook Airport, Indianapolis, many types of UHF aircraft radio receivers—including blind landing, marker, radio range and localizer equipment—are tested. All these aircraft receivers operate from 12 or 24 volts DC, supplied by a Mallory Rectopower Supply.

Designed to replace batteries, battery carts or motor generators wherever DC power is required, Rectopower is the most convenient way to assure a dependable source of DC. Rectopowers are designed to operate from any 208 and 230 or 440 volt AC 3 phase 60 cycle outlet.

For manufacturing, testing and repairing electrical and electronic equipment, as well as for taper charging batteries—on assembly lines, in laboratories and maintenance shops—Mallory Rectopower Supplies are favored by engineers. Rectopower units operate silently and give exceptionally long life, because they are equipped with Mallory magnesium-copper sulphide dry disc rectifiers—which have no moving parts.

Ask your nearest Mallory Distributor for further information, or write us today.

P. R. MALLORY & CO., Inc.,
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*Rectopower is the registered trademark of P. R. Mallory & Co., Inc., for rectifier power supply units.

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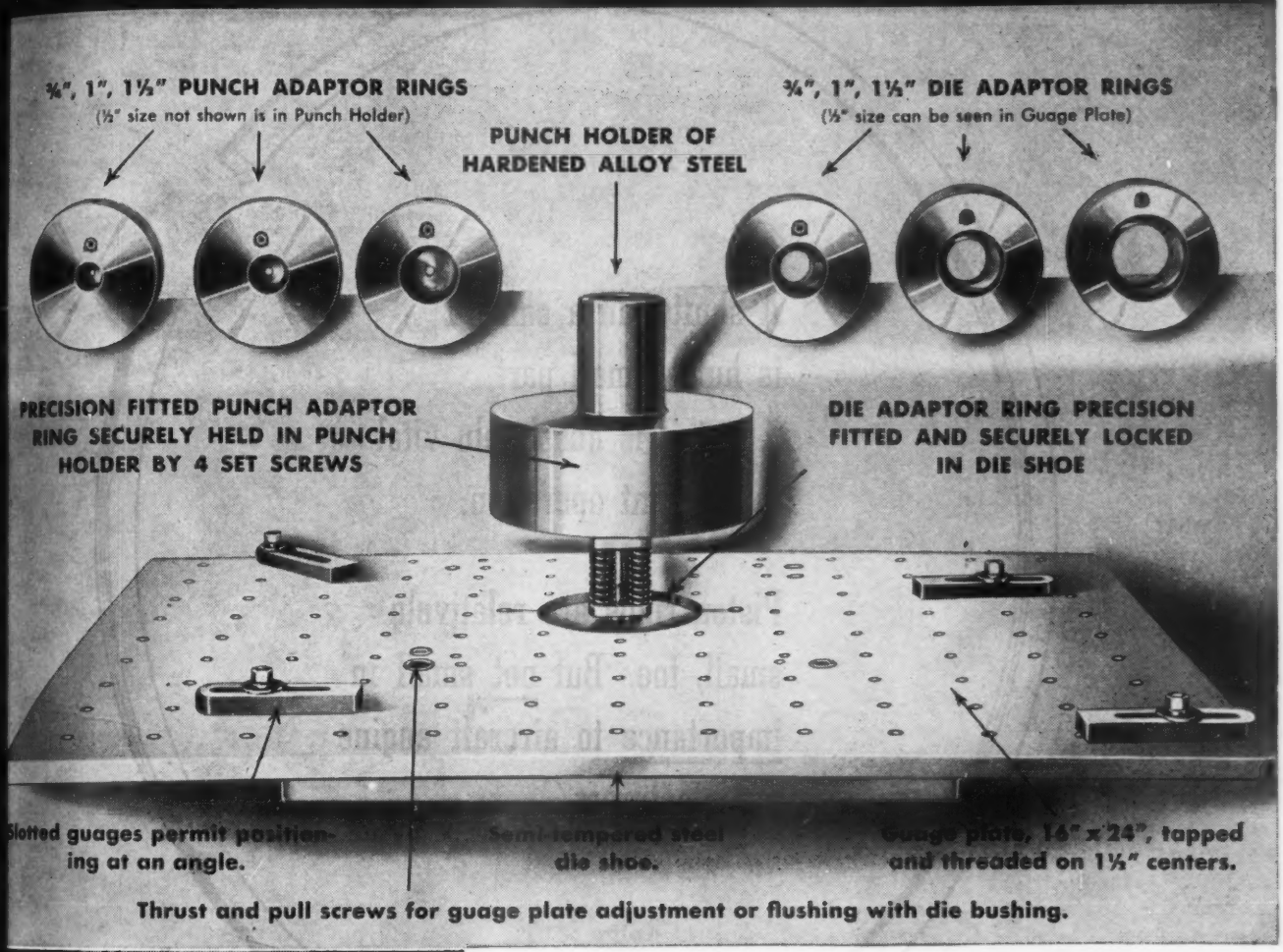
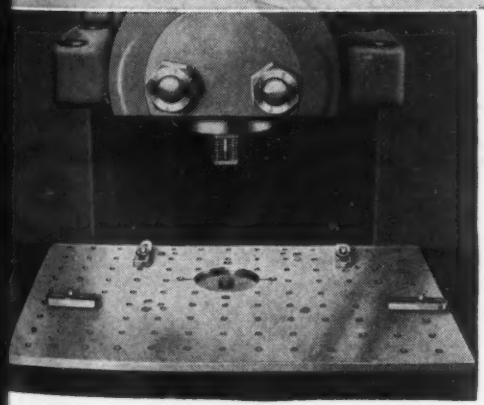
MAGNESIUM COPPER SULPHIDE RECTIFIERS—
STATIONARY AND PORTABLE D. C. POWER SUPPLIES—
BATTERY CHARGERS AND AVIATION RECTOSTARTERS*

WHISTLER SINGLE HOLE PERFORATOR


¾", 1", 1½" PUNCH ADAPTOR RINGS
(½" size not shown is in Punch Holder)
PUNCH HOLDER OF HARDENED ALLOY STEEL
¾", 1", 1½" DIE ADAPTOR RINGS
(½" size can be seen in Guage Plate)
PRECISION FITTED PUNCH ADAPTOR RING SECURELY HELD IN PUNCH HOLDER BY 4 SET SCREWS
DIE ADAPTOR RING PRECISION FITTED AND SECURELY LOCKED IN DIE SHOE
Slotted guages permit positioning at an angle.
Semi-tempered steel die shoe.
Guage plate, 16" x 24", tapped and threaded on 1½" centers.
Thrust and pull screws for guage plate adjustment or flushing with die bushing.

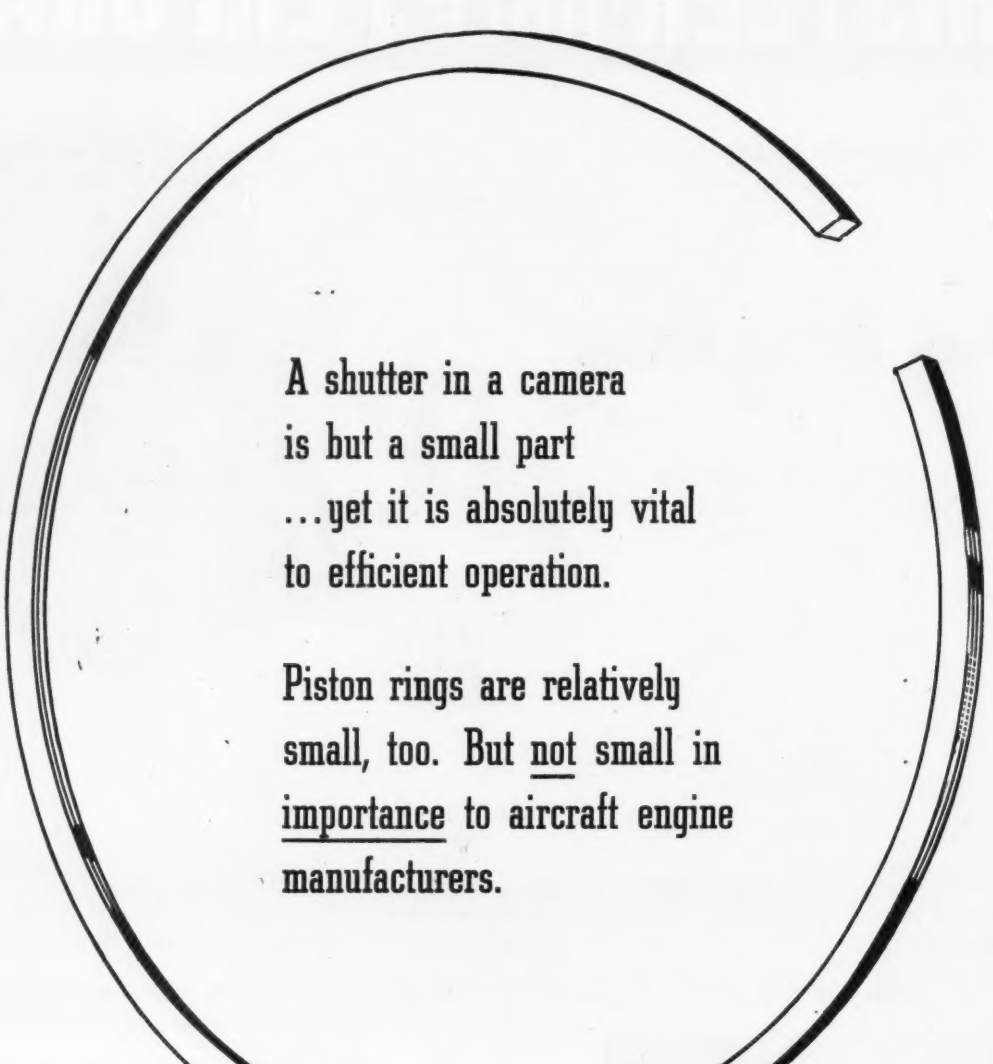


Shown above is the U-5015 Whistler Single Hole Perforator Set complete and at the left, the set on the press ready for production—the answer to quick and economical handling of many perforating jobs. It takes but a few minutes to bolt in the punch holder and position the guage plate and die shoe which are set on the press as a single unit. Punch and die adaptor rings of the four sizes are changed instantly by loosening then tightening two set screws. The same procedure is followed for changing sizes of punches and dies. Absolute precision is assured. Punches, dies and strippers are extra. Shipped within a few days in standard sizes from 1/32" to 1½" in round, square, oval and rectangle shapes for perforating materials to 1/4" thick mild steel. Operating satisfaction is guaranteed by Whistler's 28 years of experience in the manufacturing of production perforating equipment. Whistler Single Hole Perforator Unit complete F. O. B. Buffalo **$465**

S. B. WHISTLER & SONS, Inc. 752-756 Military Road, Buffalo 17, N. Y.

REPRESENTATIVES IN ALL PRINCIPAL CITIES

Get in touch with WHISTLER for all types of sheet metal dies!



A shutter in a camera
is but a small part
...yet it is absolutely vital
to efficient operation.

Piston rings are relatively
small, too. But not small in
importance to aircraft engine
manufacturers.

The world's finest piston rings are standard equipment for these world-famous aircraft engines — Allison • Wright • Studebaker-built Wright • Buick-built Pratt & Whitney • Warner • Packard-built Rolls-Royce • Franklin

The Perfect Circle Companies

Hagerstown, Indiana • Richmond, Indiana • New Castle, Indiana • Tipton, Indiana • Toronto, Ontario, Canada

Only "Spring-life" can meet Bellows requirements like this

REQUIREMENTS:

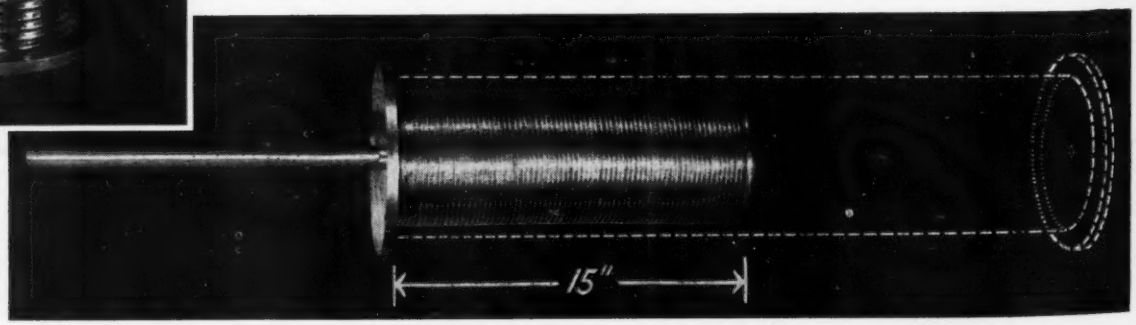
A bellows to be used as a piston within a cylindrical housing 30" long by 6½" O.D. to give a displacement of a minimum of 240 cubic inches.

FULFILLMENT:

To meet this requirement, a "Spring-life" bellows 5⅞" O.D., made of tinned phosphor bronze with 68 flanges or convolutions, was constructed. The free length of this bellows is 25". In order to satisfy the requirement of 240 cubic inches displacement, this bellows must travel 15". This is accomplished by extending the bellows 5" from its free length and compressing it 10" from its free length. The drive shaft is made of stainless steel rod and is guided internally on a stainless steel tube. Life expectancy of this unit is 300 million flexures at the rate of 50 per minute, or a total of 19 years continuous operation without undue surges and when operated within its elastic limits.

Here is another example of what was an unusually difficult problem until Cook engineers solved it and added another page to their file of "impossible" jobs accomplished.

Many of the largest manufacturers in the country consistently "Look to Cook" to solve their unusual problems. They have learned that we do not tolerate the word "can't." This attitude of the Cook engineering staff can be of service to you.



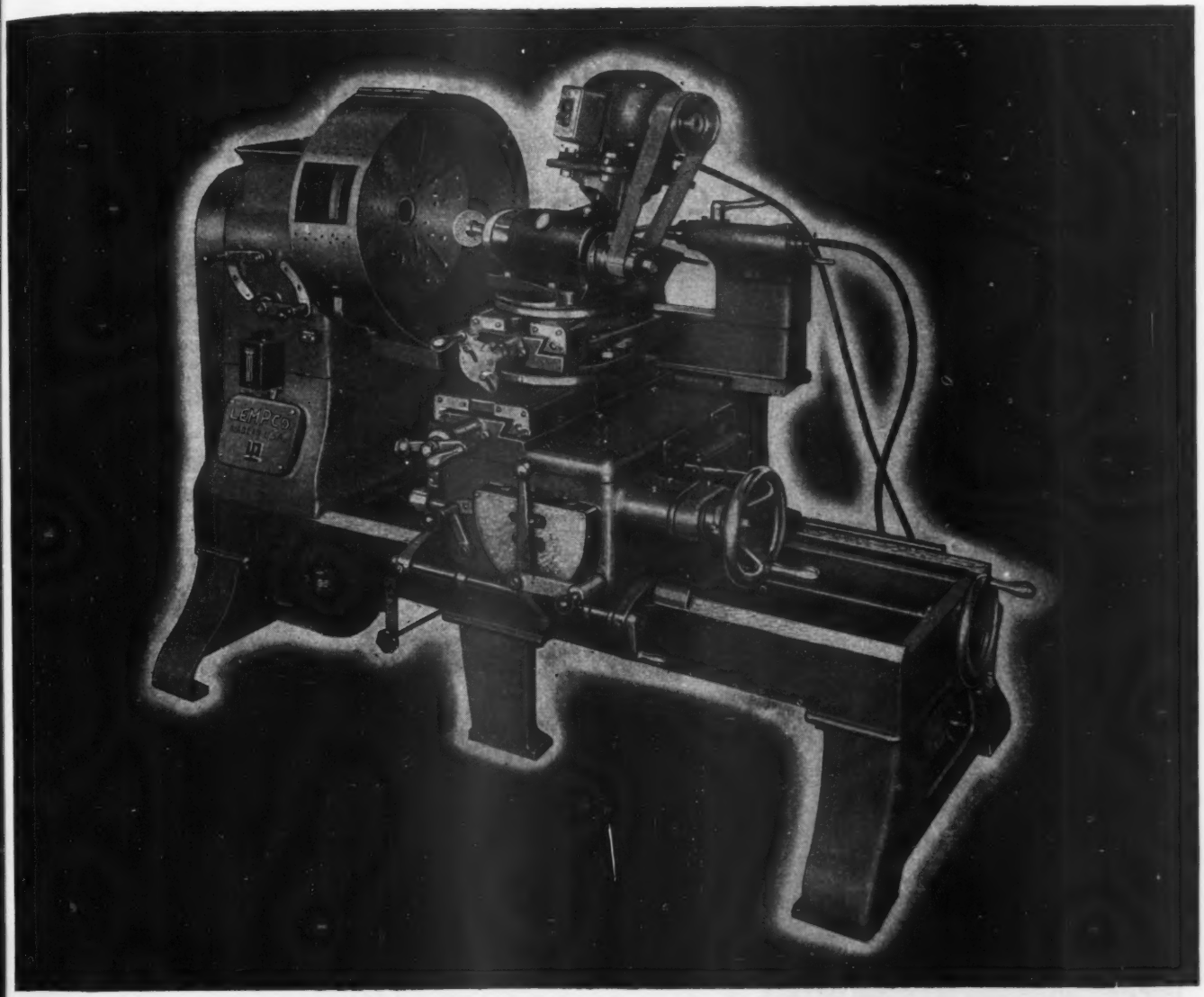
This book will give you the complete story of the 7 advantages of "Spring-life" construction

COOK ELECTRIC Company

"Spring-Life" Engineered Bridge to Giant Size Bellows

2700 SOUTHPORT AVENUE · CHICAGO 14, ILLINOIS

Here is a new book just off the press that contains the complete story of the Cook "Spring-life" idea, its history, its advantages, its applications, and complete data for specifying and ordering Cook "Spring-life" Bellows.



TASK FORCE

On the production front, this modern Lempco heavy-duty universal grinder is doing such a variety of important jobs that it's a veritable task force in itself. Its huge 53" swing enables it to do many jobs that no other grinder in its price range can do. It does fast precision turning and grinding on internal, external, face and taper jobs. Exclusive Lempco quick set-up hollow spindle draw-bar mounting. Change-over from grinding to turning in a few minutes. Quick-change spindle speeds and carriage feeds automatic in both directions. Excellent delivery. Ceiling-priced.

WRITE FOR DETAILED ILLUSTRATED CIRCULAR

LEMPCO

5497 DUNHAM RD. • BEDFORD, OHIO

LINEAR "Par" Packings
. . . HELP *SAFEGUARD* HYDRAULIC PRESSURE

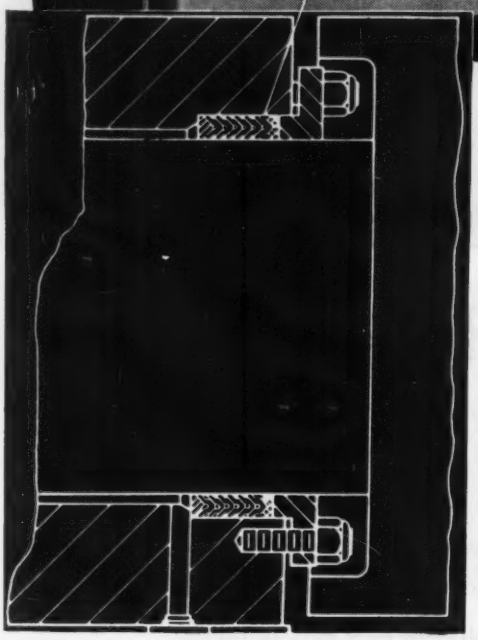


Photo of Molding Machine and sketches showing application of Linear "Par" packings to clamp and injection cylinder . . . courtesy of The Hydraulic Press Mfg. Co., Mt. Gilead, Ohio, U. S. A.

Sealing in hydraulic power from zero to peak pressure, which aids in the delivery at the ram of the *maximum* pressing force produced, is the highly important function of packing rings. To this end, extra care should be given to their selection.

For this FASTRAVERSE Injection Molding Machine, H-P-M designated Linear "Par" packings to insure the fluid tight seal which is the direct result of Linear's correct design, proven production methods and painstaking inspection.

Top performance of any hydraulically operated mechanism depends upon its careful control throughout the operating cycle . . . and Linear "Par" packing rings contribute to this rigid control . . . help *safeguard* hydraulic pressure.

Made in six compositions, each for a particular service, "Par" packings comply with the specifications of the ever increasing range of modern hydraulic equipment.

Sample packings sent upon request. Engineering consultation, resources of our testing laboratories and facilities for the complete design of the hydraulic unit itself are available.

LINEAR
PACKING & RUBBER CO.
STATE ROAD & LEVICK STREET
TACONY, PHILADELPHIA 35, PENNA.

"WE GOT 'EM"

"We came at them out of the sun—peeled off, gave them the works and were upstairs again in a jiffy. Boy, that Allison's an engine!" Praise like that comes from deep down in a pilot's heart! Dependability like that supports his confidence, his daring and his ability to win battles. It's another reason why more than 65,000 Allison engines have been supplied to our fighter pilots on all fronts. ★ And when peace comes, Allison's war-proved dependability will contribute to the fine flying qualities of planes in which you'll ride.

KEEP AMERICA STRONG
BUY MORE WAR BONDS

POWERED BY ALLISON

P-38—Lightning
P-39—Airacobra
P-40—Warhawk
A-36 and P-51A—Mustang
P-63—Kingcobra

Allison already has furnished more than 85,000,000 H. P. for use in these planes.

LIQUID-COOLED AIRCRAFT ENGINES

Allison

DIVISION OF
Indianapolis, Indiana

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GENERAL MOTORS

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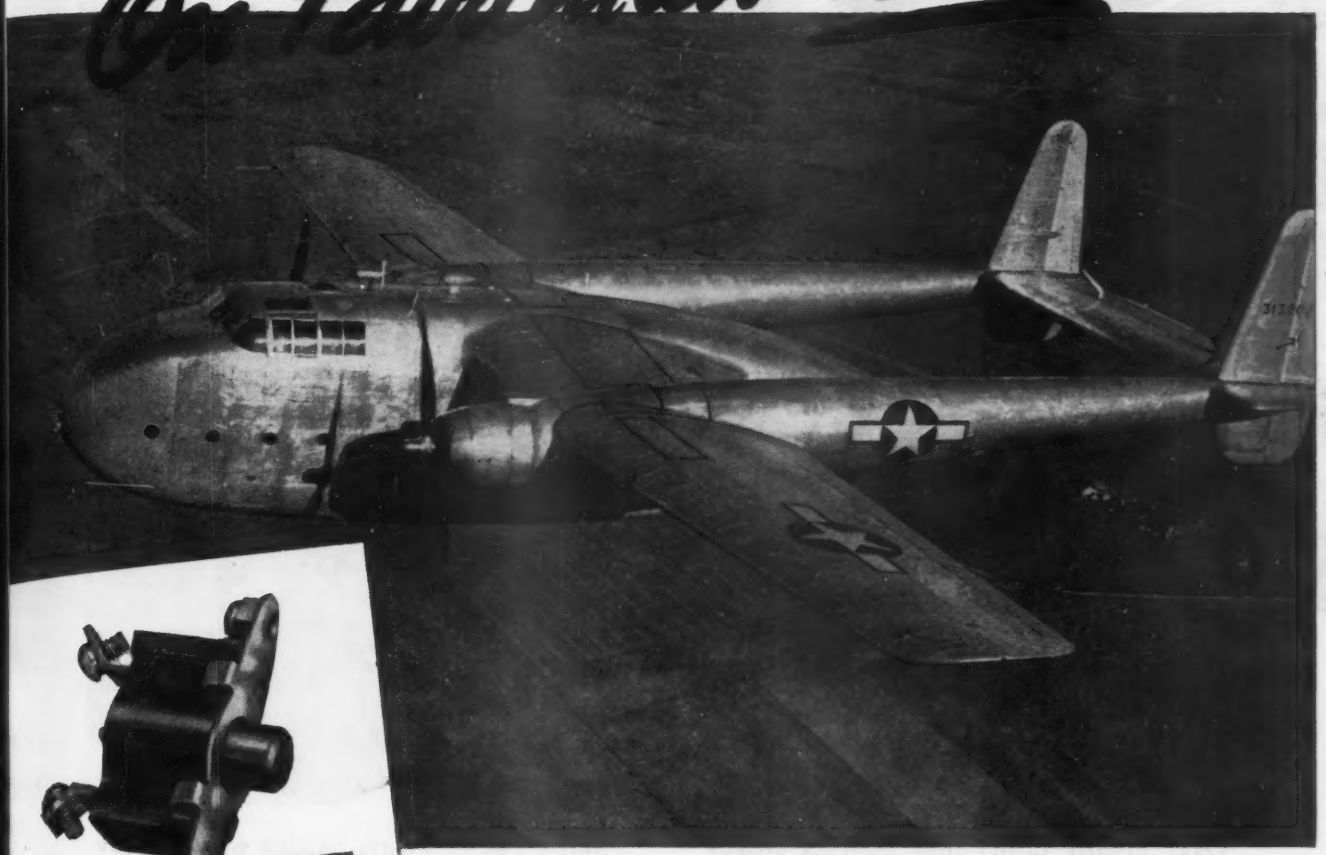
LARGEST INDEPENDENT MANUFACTURERS AND CUTTERS OF FELT

Klixon Aircraft Circuit Breakers Safeguard Electrical Circuits On Fairchild's Packet



Circuit breaker panel on the Fairchild "Packet" showing some of the Klixon PSM Breakers (Army No. 43A8304) which protect the electrical circuits in this modern "flying box car."

Newest and most efficient of the Army's air cargo carriers is the Fairchild "Packet" . . . an all-purpose "flying box car." Included in its many Fairchild design features are—nine-ton cargo load, over 3500-mile range, low-speed landings and quick take-offs, quick conversion to an ambulance plane, fine flying characteristics. So pleased are the Army Air Forces with its versatility that the "Packet" will be built by both Fairchild and North American to assure quantity deliveries of this famous cargo carrier.

Into every "Packet" go many PSM Klixon Aircraft Circuit Breakers to protect electrical circuits from nose to tail. These compact, light-weight Klixon Breakers guard against the possibility of damage to the electrical system from shorts or overloads. They perform accurately and efficiently regardless of shock, vibration, motion or altitude.

Klixon Aircraft Circuit Breakers are available for all types of planes in push-button, indicating and non-indicating, switch, remote and automatic reset types. Bulletins giving sizes, dimensions and performance characteristics will be sent on request.

ARMY E NAVY

KLIXON

SPENCER THERMOSTAT COMPANY, ATTLEBORO, MASSACHUSETTS

EXIDES RIDE WITH THEM MISSION AFTER MISSION

Over enemy lands they roar, a steady stream of them, hurling their might through every hour of day and night! On scores of thousands of those bombers and fighters are Exide Batteries . . . performing as dependably as the marvelous planes they serve.

Since 1917, when the first battery-equipped plane left the ground, Exides have been serving aviation's battery needs. And when the last smoke of battle blows away, Exides will be serving those other thousands of commercial and private planes, which soon will usher in a new era of aviation progress. Exides will be serving then, as now, with dependability, long-life and ease of maintenance.

A LETTER FROM THE PACIFIC THEATRE

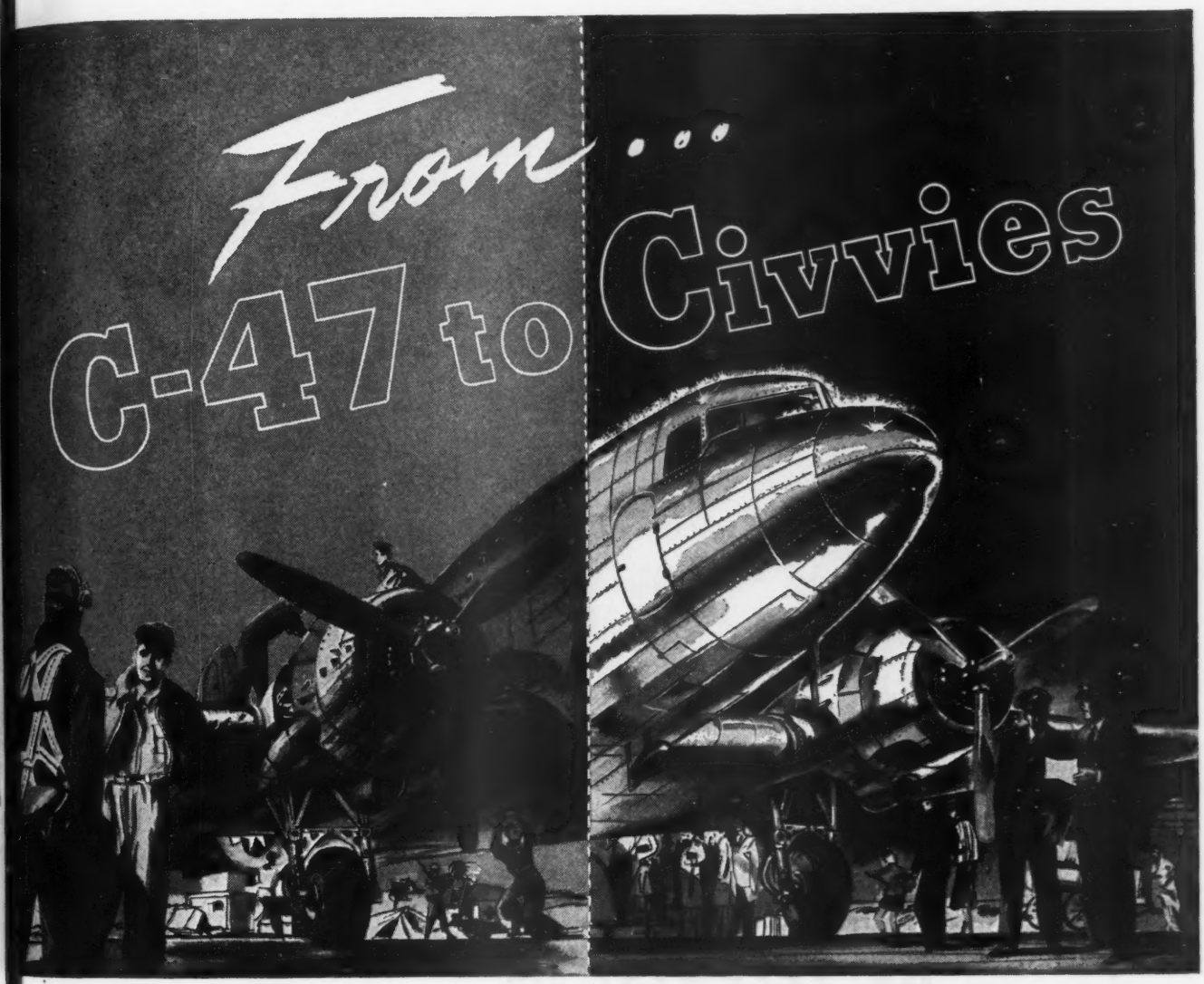
Letters are regularly received from many of the more than 1400 Exide employees in the service. This one comes from the Southwest Pacific:

"The other day we had some batteries transferred to our ship. After getting them aboard, I had a look at them. Sure enough, they were Exides. Boy, that sure made me feel good . . . running into Exide Batteries way out here."

ARMY E NAVY

Exide
AIRCRAFT
BATTERIES

THE ELECTRIC STORAGE BATTERY CO., Philadelphia 32
Exide Batteries of Canada, Limited, Toronto



NO TIME IS WASTED in changing the C-47 over to civilian life. A commercial airline job is waiting when each ship's Army service is completed; and the cleaning necessary for this reconversion from military transport to civilian airliner is speeded by Kelite pH Control.

Engines are removed for production line overhaul. The ship is blocked up off the ground. Rubber, plexiglas and fabric surfaces are masked off. Interior floor boards are removed and sections of the belly skin wedged open for easy drainage.

KELITE PROTEXOL is sprayed around the fire wall, inside wheel wells, underneath the belly, inside the bottom of the fuselage to wet out oil and grease. Exhaust stains are wiped off with KELITE KDL No. 28. The ship is steam cleaned inside and out with KELITE KDL No. 1 and then rinsed off with cold water.

The stripping crew goes to work with KELITE AC STRIPPER, spraying it on, allowing time for the stripper to soak in, and brushing it off. Two applications of stripper and a water rinse take off the khaki drab. Masking is removed. And we see a clean but naked looking DC-3.

Then, all aluminum surfaces are polished with KELITE KERO to restore the original lustre and protect the metal. Rebuilt engines and interior furnishings are installed. Airline insignia is painted on. And a proud-looking Douglas airliner is ready for its new civilian job!

Problems involved in the rapid removal of stubborn soils and finishes from easily harmed surfaces such as Alclad are greatly simplified by Kelite materials and methods which take full advantage of scientific pH Control.

By constant adherence to the pH chart, which accurately measures the cleaning power needed for every type of soil removal and shows the exact limits of safety for the surface being cleaned, Kelite has taken the guesswork out of cleaning . . . provided a reliable key to a new, high standard of efficiency.

"Kelite" Reg. U. S. Pat. Off., Chart copyrighted 1942 by Kelite Products, Inc.

KELITE

SCIENTIFIC CLEANING THROUGH pH CONTROL

KELITE pH Control

Executive Offices: 909 E. 60th St., Los Angeles 1. Manufacturing plants in Los Angeles, Chicago, Perth Amboy, Houston. Branches in principal cities.

PRECISION Lawson

By TELEVISION YOU WILL SEE PRECISION

● In television it's pin-point accuracy — .001″ means distortion. In many phases of modern warfare this same super-accuracy pays off in victory!

● Today, the precision machining of quality parts at Lawson's is devoted entirely to the production of war material. We will continue so, until that time when our skilled craftsmen may apply their precision work to your engineering needs and problems.

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SCHATZ
BALL BEARINGS

WILL NOT FAIL *THEM*

WHEN THEIR LIVES DEPEND UPON THAT TERRIFIC PULL COMING OUT OF A 500 M.P.H. DIVE . . .

SCHATZ CONTROL BEARINGS ARE BUILT RUGGEDLY FOR STAMINA AND DEPENDABILITY

THE SCHATZ MANUFACTURING COMPANY
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FABSEAL ... helps to span Continent in 6 hours!

SENSATIONAL aviation history was recently made when a Boeing C-97, super cargo and troop transport, spanned the continent from Seattle to Washington — 2,323 miles — *in six hours, three minutes and 50 seconds!*

Such phenomenal speed could have been achieved only in the stratosphere. Stratosphere flying is made possible by a pressurized cabin in which every seam, window and door is thoroughly sealed.

The pressurized compartments of the Boeing C-97 were made airtight with FABSEAL which is a new and exclusive development of the Industrial Paint Division of the Pittsburgh Plate Glass Company.

FABSEAL is a flexible, fabric-impregnated tape which has excellent adhesive characteristics. It remains sufficiently flexible at low temperatures to withstand the rigorous demand of flight service at high altitudes.

Exacting and extensive tests have proved it to be greatly superior for this type of service.

Literally miles of FABSEAL have been used to make thousands of American fighting planes airtight and insure water, oil and gasoline integr

Pittsburgh Aircraft Finishes

Camouflage Finishes . . . Protective Coatings for Wood and Fabric Surfaces . . . Zinc Chromate Primers for Metal . . . Lacquers, Clear and Pigmented . . . Dopes, Clear and Pigmented . . . Sealers and Surfacers for Wood . . . Plywood Finishes . . . Paints . . . Spar Varnishes . . . Heat-Resisting Enamels . . . Slushing and Sealing Compounds for Fuel Tanks . . . Caulking and Glazing Compounds . . . Chromseal Ribbon Compound . . . Fabseal Impregnated Tape . . . Chromseal Tape . . . Stratoseal Cabin-Sealing Tapes . . . Army and Navy Specification Finishes . . . Commercial Finishes for Post-War.

PITTSBURGH PLATE GLASS COMPANY, Industrial Paint Division, Pittsburgh, Pa. Factories: Milwaukee, Wis.; Newark, N. J.; Houston, Texas; Los Angeles, Calif.; Portland, Ore. Ditzler Color Division, Detroit, Mich. The Thresher Varnish Co., Dayton, O.

PPG **PITTSBURGH** *Industrial* **FINISHES**

PITTSBURGH STANDS FOR QUALITY PAINT AND GLASS

For SPECIAL ELECTRICAL EQUIPMENT DESIGNED AND BUILT TO QUALITY STANDARDS *Consult*

LEECE-NEVILLE

LEECE-NEVILLE has always specialized in designing and building electrical equipment to the customer's specifications. And into each special job goes the same foresighted engineering and the same high quality construction for which Leece-Neville has been respected since 1910. That's why any special equipment by Leece-Neville will meet your requirements better . . . serve you more dependably . . . last you longer.

Special equipment designed new or achieved by modifying existing equipment in our line will be produced in only a few units if desired. But greatly increased manufacturing capacity will permit us to offer members of the aircraft industry quantity production—and the economies that go with it. Just send a brief outline of your requirements. We'll do the rest—subject, of course, to existing regulations.

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GENERATORS • VOLTAGE REGULATORS SWITCH RELAYS • PUMP MOTORS

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CLEVELAND 14, • OHIO • U·S·A·

These "World's Smallest Transformers" May Be The Complete Answer to Your Space and Weight Problems!

It's not an everyday occurrence when so large a problem can be answered with such a small unit. In fact, we're mighty proud of this midget transformer achievement—not only for the reason that Permoflux engineers met a vital war challenge, but because of its numerous practical applications. Permoflux welcomes inquiry from design engineers about this midget transformer development.

BUY WAR BONDS FOR VICTORY!

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AIRCRAFT VISION for VICTORY

with a

LIBERTY AIRCRAFT MIRROR

The pilots of thousands of Allied fighter planes, now in action over our widely scattered battle fronts, are getting a perfect image of things behind them without eye-strain or fatigue, by means of Liberty Aircraft Mirrors.

Liberty Aircraft Mirrors are all first surface mirrors, and as permanent as their glass base. They give the pilot a clean, well defined image without distortion, immediately.

Each fighter plane equipped with a Liberty Mirror has a mirror built to meet the specific requirements of that plane. Thus the pilot changing from one plane to another gets uniformly good vision at all times, in all planes.

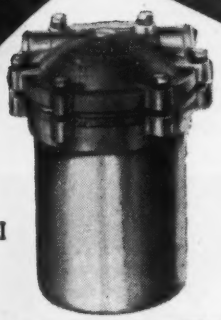
All Liberty Mirrors are now built only for War service, but later these battle tested vision devices will be available to all operators, military, transport or private.

LIBERTY
MIRROR DIVISION

LIBBEY-OWENS-FORD GLASS COMPANY
BRACKENRIDGE
PENNSYLVANIA

For continued outstanding production Liberty has been granted a renewal of the Army-Navy Production Award, entitling them to add a star to their "E" flag.

TAIL END CHARLIE...



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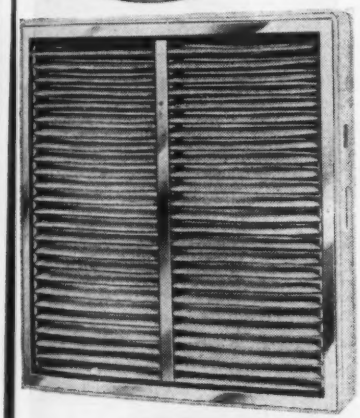

2

3

BOY, oh Boy, what a life is his. Only too often the first to be attacked by some enemy plane sneaking up on the tail of his machine. Usually the last to fight his way free from some pretty hot engagement . . . certainly "Tail-end Charlie" has no cushy job especially on Night-Op's.

But trained to the minute for his job with every possible contrivance to ensure the smooth working of the mechanism he controls, "Tail-end Charlie" just concentrates on his job . . . shooting 'em down and chalking 'em up.

And just where do Vokes Filters come into the story. Right here. Vokes Air, and Oil Filters are fitted to the aircraft he is flying whether it be British, Canadian or American. Vokes Air Filters supply 99.9% clean air to aero-engines. Vokes Oil Filters are used for main pump filtration of those engines. Vokes Low and High Pressure Filters for gun turrets are also fitted and incidentally also for retractable undercarriage hydraulic mechanism. Then again there is the Vokes Flametrap Silencer for both radial engines and in line engines extinguishing tell-tale exhaust flames.

Fighters, bombers, reconnaissance machines of British, American and Allied Air Forces operating in all battle areas have been fitted with Vokes Filters and have stood up to all demands made upon them. The practical experience gained we gladly place at the disposal of designers and producers of aero-engines and aircraft. We believe that this experience can be used not only to prolong the life and efficiency of aircraft, but help to secure added success and greater safety for our valiant fighters of the air and "keep 'em flying."

Vokes have produced over 3,000 models of their filters and, of course, provide the necessary housings and ducting systems. If you have any filtration problem consult Vokes, the pioneers and specialists in this work.

1. Vokes Oil Filter for Aircraft. **2. Vokes Millevee Filter Element.**
3. Vokes typical Air Filter for Aircraft.

VOKES FILTRATION & SILENCING CO. INCORPORATED, 101, Park Avenue, New York, & VOKES (CANADA) LTD., 1123, Bay Street, Toronto, Canada, *Contractors to British and Dominion Governments.*

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DESIGNERS, PATENTEES & MANUFACTURERS OF AIR, OIL & FUEL FILTERS & SILENCERS

EVEN THE ZULUS

UNDERSTAND THIS LANGUAGE
—JUST ONE NIGG *ADJUSTABLE*
STUD FITS ANYTHING

Nigg *Adjustable* Studs speak a universal language. They are interchangeable, without modification, in any United-Carr, Shakeproof, Chicago or Right Way installation. You need carry *only one Nigg size* (instead of 48). The center screw adjusts the cross pin to fit *any thickness* from .021" to .500" (a range of nearly ½ inch). Then you lock and unlock the stud in the usual way.

Simple — universal — and approved for use on AAF and U.S. Navy airplanes and by the C.A.A. Write for samples. Eastern and Midwest inquiries address United-Carr Fastener Corp., 37 Ames St., Cambridge 42, Mass. Pacific Coast inquiries to Nigg Engineering Company, 537 No. 2nd St., Covina, Calif.

NIGG

ENGINEERING COMPANY

COVINA, CALIFORNIA

the EQUITABLE POLICY

Since the war began we have devoted ourselves largely to the production of bearings to special dimensions and we expect that because of our wide experience in their construction, these bearings will continue to be a large part of our output. However, we are now devoting an increasing amount of our facilities to the production of *many standard bearings* and we have just published our new 28 page bearing catalog showing in detail the complete line of Equitable Standard bearings. We continue to offer to work with your engineers in the design, application and service of any type of anti-friction bearing on which you may ask specialized advice. Look to Equitable for bearing information for *any* type application, standard or special.

Write for our new catalog No. 44

Equitable
BEARING CO. Inc.
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WALDEN, NEW YORK

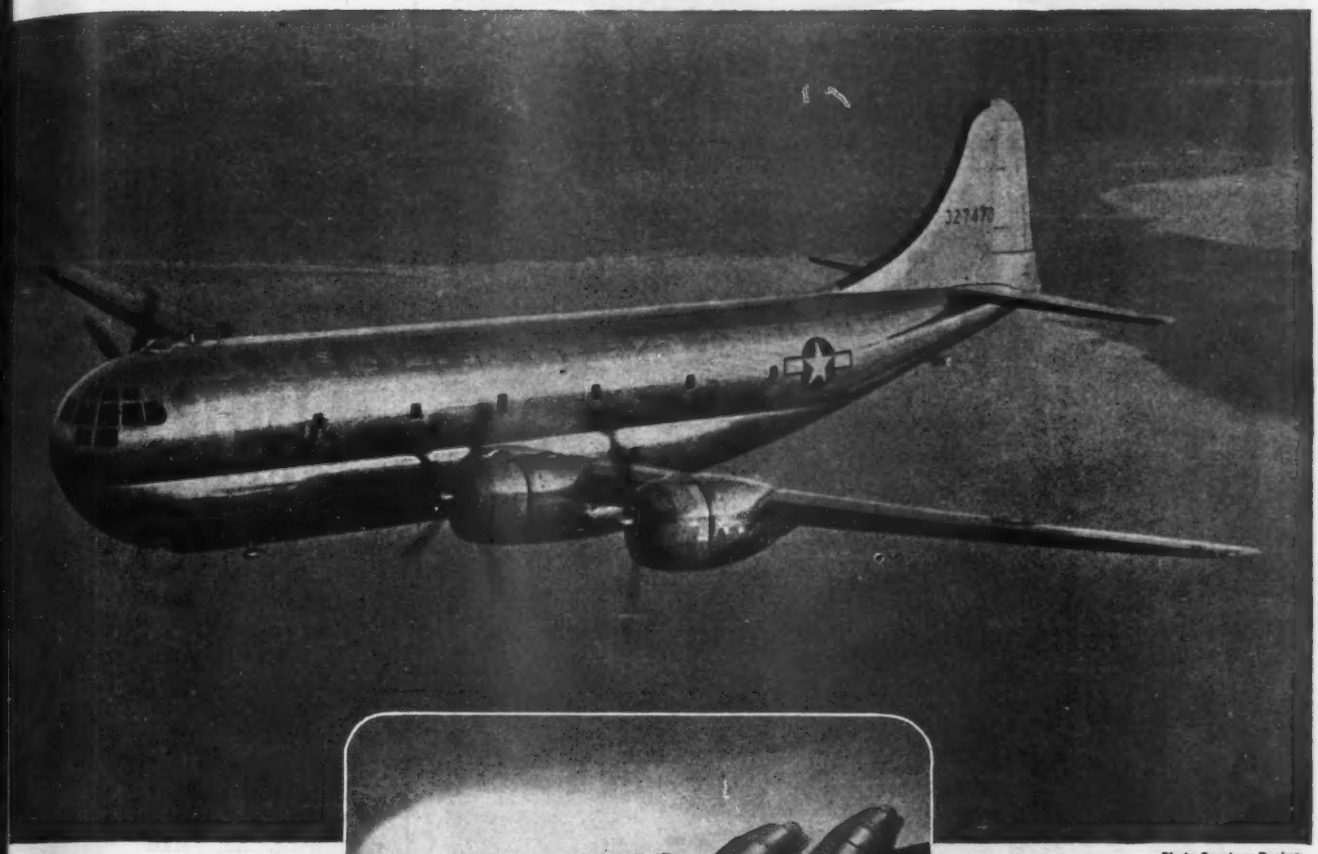


Photo Courtesy Boeing

Above, the new Boeing C-97 Army Transport which exceeds all existing AAF transports in range, pay load, and size.

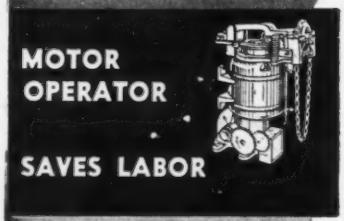
Left, type of Barber-Colman Control Equipment used to maintain uniform temperature in the C-97 passenger cabin.

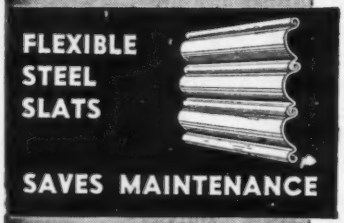
BARBER-COLMAN CONTROLS

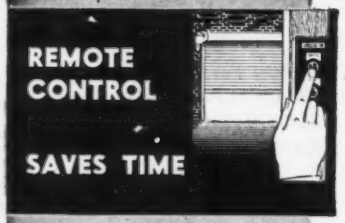
HOLD UNIFORM TEMPERATURE IN PRESSURIZED CABIN OF C-97

BOEING'S Model 377 Stratocruiser, the postwar version of the C-97 Army Transport, will carry 100 passengers in luxurious comfort, for operating ranges up to 3,500 miles with ample fuel reserves. One feature of this luxury, as already demonstrated in the C-97, is a huge pressurized double-deck cabin maintained at low-level conditions *and uniform temperature* in all weather and at all altitudes up to 30,000 feet or higher. Barber-Colman Controls which provide uniform temperature consist of Power Units on the right-hand and left-hand heat exchanger dampers, the warm air supply from one side being governed by a Micropositioner in the aft cabin space and from the other side by a similar unit forward. A manual switch controls two other Power Units on dampers which can divert the heat supply for anti-icing, at the same time connecting a Thermostat to prevent excessive duct temperatures. A manual emergency switch transfers the limit thermostat control to either right or left-hand heat supply when needed. The Power Unit circuits also have master on-off-automatic control switches. This is an excellent example of how Barber-Colman Aircraft Controls, specially designed for accuracy, high power, light weight, dependable operation, maximum performance, and minimum maintenance, can be engineered to produce desired results under extreme conditions.

BARBER-COLMAN COMPANY
1221 ROCK STREET · ROCKFORD, ILLINOIS







No time or effort is wasted in opening (or closing) the Kinnear Motor Operated Door. Just a touch on the control button and the sturdy motor operator goes instantly into action, coiling the flexible steel slat curtain up out of the way, and clearing the opening completely. Floor and wall space can be utilized to within a few inches of the door.

The Kinnear Motor Operator, featuring a specially designed torque output motor, machine cut gears and bronze bearings is built into an integral unit of exceptionally long life and durability. Remote control switches can be installed at convenient points to save additional steps and time. The flexible steel slats of the curtain are strong and rugged, and are built to withstand years of continuous use.

These and many other Kinnear advantages add up to make the Kinnear Motor Operated Door a good investment. Plan to cut your door costs with the door that has proven its dependability . . . in many cases serving continuously for over 40 years.

Kinnear Doors fit openings of any size and are built to your individual needs. Write now to the Kinnear Manufacturing Company. Factories: 1440-60 Fields Avenue, Columbus 16, Ohio; 1742 Yosemite Avenue, San Francisco 24, California.

SAVING WAYS IN DOORWAYS

KINNEAR
ROLLING DOORS

250,000 Life Saving PARACHUTES

. . . is a Production Record of which we are justly proud for this leadership will be the background for our post-war commercial business.

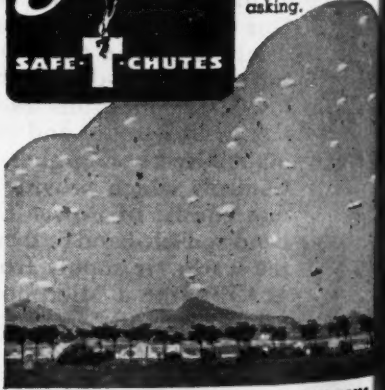
Our output today goes to meet war's demands. In like manner Switlik Safety Products tomorrow will play an important part in the peace-time pattern.

Wherever you fly —whenever you fly —wear a SAFE-T-CHUTE, for it is truly "the life line of the skies."

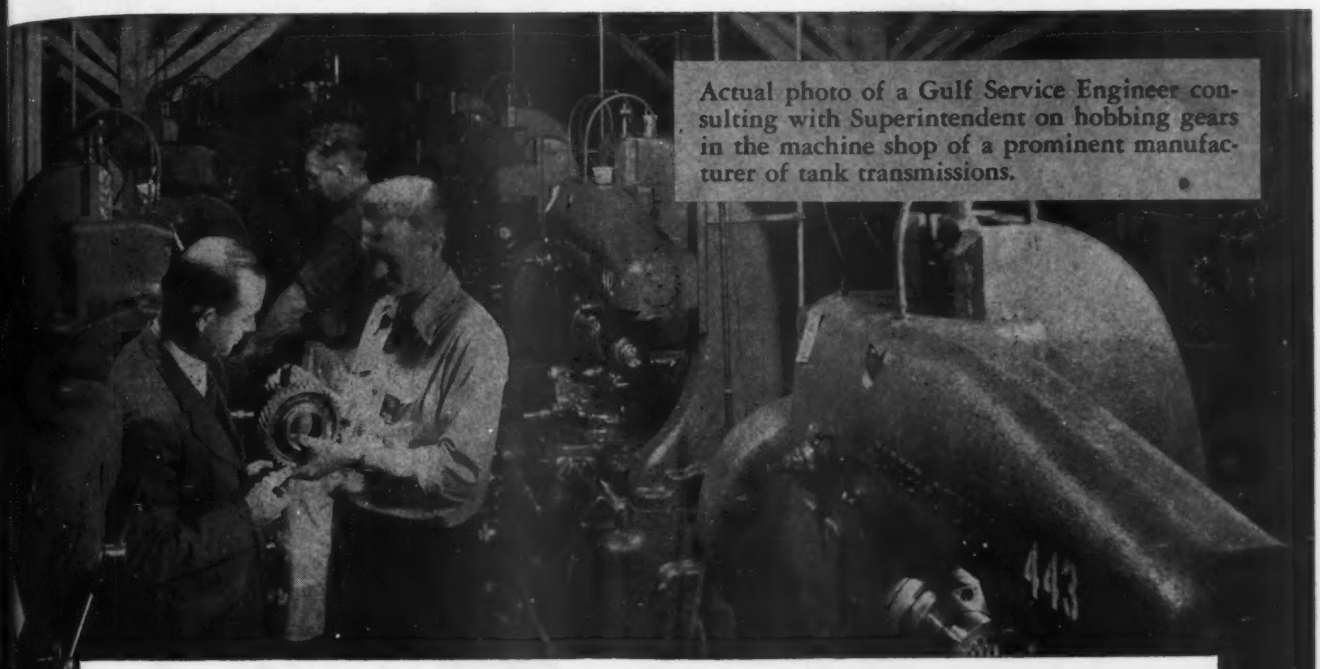
SWITLIK
SAFE-T-CHUTES

Educational air safety film available for colleges—training schools—high schools.

ALSO write for the informative Switlik Parachute Chart and new manual. All free for the asking.



SWITLIK PARACHUTE COMPANY
Dept. G5 TRENTON 7, NEW JERSEY



Actual photo of a Gulf Service Engineer consulting with Superintendent on hobbing gears in the machine shop of a prominent manufacturer of tank transmissions.

"With

Gulf Cutting Oils

we reduced rejects and increased tool life"

says this Superintendent

GULF CUTTING OILS have been a big help to us in exceeding our production goal," says this Superintendent. "By switching to these improved oils, we eliminated rejects due to tearing, and made a substantial increase in tool life."

Again and again, Gulf Cutting Oils have set new standards of performance for tough jobs in hundreds of aircraft, armament, and munition plants. And war production reports on Gulf Cutting Oils have a peacetime value: These quality cutting oils can give important help to shops seeking lower costs for aggressive competition in the postwar period.

Gulf Cutting Oils are available to you through 1200 warehouses located in 30 states from Maine to New Mexico. Write, wire, or phone your nearest Gulf office today.

GULF INDUSTRIAL LUBRICATION

Gulf Oil Corporation · Gulf Refining Company

Gulf Building, Pittsburgh 30, Pa.

STARRETT

YOU CAN CONTINUE TO COUNT ON THEM

Starrett Tools and skilled hands just naturally go together. The painstakingly acquired craftsmanship of the "world's greatest toolmakers" puts into a Starrett "Mike", Vernier Caliper, Height Gage, Dial Indicator or other precision measuring tool that certain *feel, handiness, finish* — call it what you will — that the skilled worker recognizes instantly and that inspires speed, confidence and constant accuracy on precision work.

That's why it pays to standardize on Starrett's and to specify them when you order from your supply house.

THE L. S. STARRETT CO.

World's Greatest Toolmakers

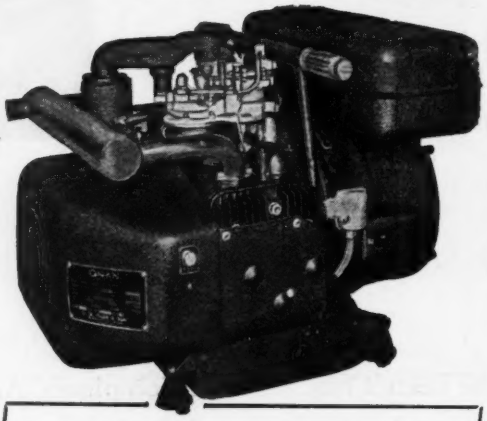
Precision Tools . . . Dial Indicators . . . Ground Flat Stock
Hacksaws . . . Metal Cutting Bandsaws . . . Steel Tapes

ATHOL, MASSACHUSETTS, U. S. A.

Now, with 3 Service Stars

ELECTRICITY

TO MEET AVIATION AND AIRCRAFT INDUSTRY POWER NEEDS



ONAN ELECTRIC GENERATING PLANTS provide reliable, economical power for many applications in the aviation industry. Available in 65 models including Airborne, lightweight, compact types. Powered by Onan-built gasoline engines, these electric plants are of compact, single-unit design. Built for heavy duty service, stationary or mobile.

▼

Successfully used by Pan American Airways—Northwest Airlines—Western Airlines—U. S. Army Air Forces—Air Transport Command—Royal Canadian Air Force.

D. W. ONAN & SONS
3134 ROYALSTON AVE.
MINNEAPOLIS 5, MINN.

ELECTRIC PLANTS
Onan
POWER AND LIGHT FOR EVERY NEED

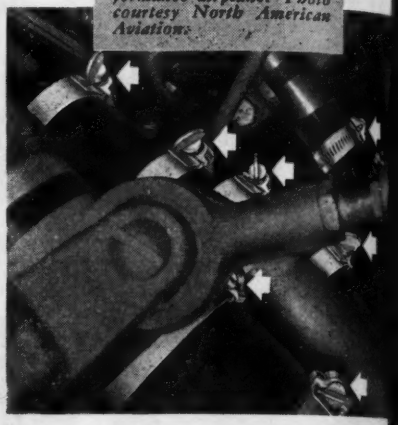
350 to 35,000 WATTS

Models range from 350 to 35,000 watts, A.C. types from 115 to 660 volts; 50, 60, 180 cycles, single or three phase; 400, 500 and 800 cycle, single phase; also special frequencies. D.C. types range from 6 to 4000 volts. Dual voltage types available. Write for engineering assistance or detailed literature.

Supply power for starter energizing . . . radio navigation . . . battery charging . . . communications . . . cabin heating . . . airport and general lighting . . . electrical repair tools . . . aircraft accessories . . . many other applications.

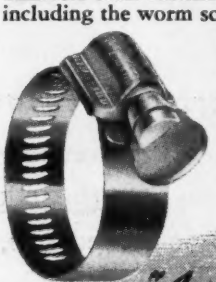
Model shown is from OTC light-weight series.

This picture shows 7 AERO-SEAL Hose Clamps of various sizes on one small portion of the coolant, oil, and fuel lines of the famous P-51 Mustang fighter. Altogether there are several hundred AERO-SEALS on this high-performance airplane. Photo courtesy North American Aviation.



It's in places like this that "Aero-Seals" prove their worth . . .

Millions of "Aero-Seal" WORM DRIVE HOSE CLAMPS are at work every day—all over the world—doing their vital job of preventing leaks in coolant, oil, and fuel lines of combat, bombing, and transport aircraft. They are doing their job under the most strenuous conditions of high pressures, severe vibration, and wide ranges of temperature. *And they are doing that job well*—justifying our claims of superior performance, high quality, and dependability. In 194 "Aero-Seals" were the first to be accepted under stringent Army-Navy Specification AN-FF-C406a. Today "Aero-Seal" Clamps are available in either Spring Steel or Stainless Steel *with the new interlocking non-welded joint between band and saddle.* The Stainless Steel models are *all stainless steel* including the worm screw. For full description, features, and engineering data, write for our new 4-page bulletin "Aero-Seal HOSE CLAMPS".



"Aero-Seal"

WORM DRIVE HOSE CLAMPS

AIRCRAFT STANDARD PARTS CO
1715 NINETEENTH AVE., ROCKFORD, ILL.

For better, faster, tighter clamping

DOLE

AIRCRAFT VALVES AND FITTINGS

To Army-Navy Aeronautical Standards

Many designers and skilled workmen have collaborated toward the result when a U. S. warplane comes "on target." The Dole Valve Company's contribution is an honest precision—an extreme care—because we know that the smallest error by any one participant can offset all the care of the rest.

Such has been the war-winning teamwork of American manufacturers. The increased skill we have gained will serve this and other industries for years to come.

THE DOLE VALVE COMPANY • Established 1906 • 1901-1941 Carroll Avenue, Chicago 12, Illinois

LOS ANGELES • DETROIT • PHILADELPHIA

... to build a BOMBER

Airplane structural specifications call for a multitude of pipe and tube bending operations in which Swan Specializes: among them engine ring mounts, landing gear forks, exhaust manifolds, carburetor insert tubes, directional finding loops, oil lines and hydraulic lines. Swan Engineering handles these and other close-tolerance pipe and tube bending jobs on a production basis, meeting rigid delivery dates. Swan's specialized plant facilities and modern streamlined production methods have effected savings in time and money for an impressive list of America's foremost plane manufacturers. Consult a Swan technician on *your* bending requirements! Our engineering department welcomes your special enquiries.

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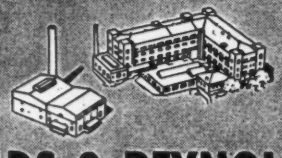
*Patent Applied for

ESTABLISHED  1866

The REYNOLDS & REYNOLDS Co.

DAYTON, OHIO

WORLD'S LARGEST PRODUCERS OF UNIFORM ACCOUNTING SYSTEMS FOR DEALER ORGANIZATIONS

YOU'LL FIND

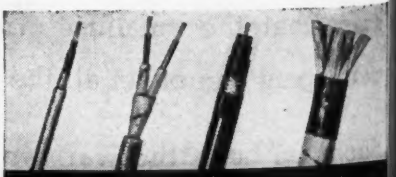
WIRY JOE

in the stratosphere!

Long famous as the largest independent manufacturer of automotive replacement wiring, Wiry Joe today is an important source of electrical cable for use in aircraft.

Produced under the Dostam method of manufacture to assure uniformity . . . dependability . . . high efficiency . . . long life, Wiry Joe aircraft ignition and lighting cable conforms fully with Army and Navy Aeronautical specification AN JC-48a; Bureau of Ships specification JAN-C-76; and Signal Corps specification 71-4943.

Inquiries concerning electrical wire and cable for aviation, marine, automotive, or industrial service will receive prompt answer.



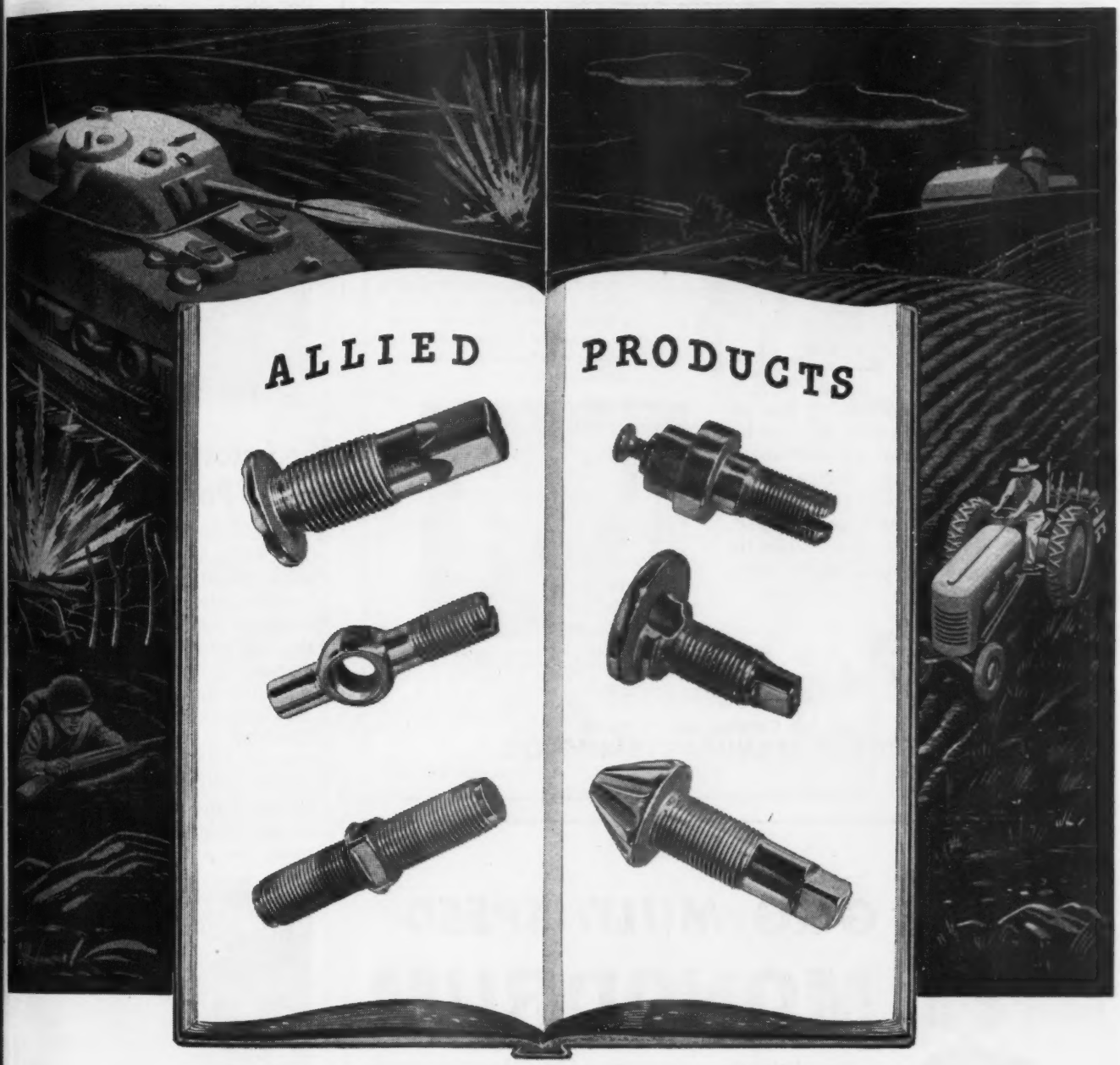
Wiry Joe

AVIATION CABLE

manufactured by

THE CRESCENT COMPANY, INC.

Pawtucket, Rhode Island



Catalog for War *and* Peace

Here are a few of the cold forgings Allied now makes by the million for thousands of tanks, tractors, trucks and other articles of war. And Allied will make these same cold forgings *in quantity,* or cold forgings very much like them, for the trucks, tractors, cars and other machines that will carry on the good life of peace.

Produced by the thousands or by the millions, each Allied forging of each type is exactly alike, fitting even the finest tolerances. Forged in one piece, from a coil of steel wire, each embodies the strength, flexibility of design and precise dimensions that make dependable quality synonymous with the Allied name. Some of the many products of Allied may solve your peacetime production problems. Anticipate those problems by consulting Allied today.

• • •

"IT'S AN ALLIED PRODUCT" . . . Allied Products Corporation in its Richard Brothers and Victor-Peninsular plants in Detroit and Hillsdale, Michigan, makes cold forged parts, cap screws, sheet metal dies (from the largest to the smallest), R-B interchangeable punches and dies, steam-heated plastic molds, jigs and fixtures and special production tools.

ALLIED PRODUCTS
CORPORATION
Department 23, 4614 Lawton Avenue, Detroit 8, Michigan

Simplify Aircraft

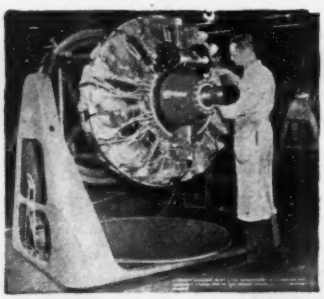
ENGINE ASSEMBLY and MAINTENANCE

WITH CLAYBORNE PORTABLE ENGINE STANDS

Photo by courtesy of Purdue University

There is Clayborne Positioning Equipment for every type of aircraft engine, besides Clayborne portable and stationary cylinder stands. The last word in design of engine handling equipment for continuous assembly lines.

With Clayborne positioning and engine handling equipment you can bypass jams and break up bottlenecks in the production line. Increase man-hour production, provide quick and easy access to every engine part, sides, top or bottom, give workers the best light and tool position for every operation this easy Clayborne way.

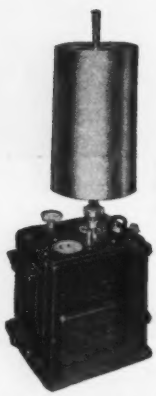


Actual Photo of Clayborne Engine Stand Model AC-24 on the assembly line of Wright Aeronautical Corporation.

Write for Catalog sheets today

CLAYBORNE MANUFACTURING CO.

4565 W. Lake Street **Chicago 24, Ill.**



G&G *MULTI-SPEED* MONODRUM

$91. NET
FOB, Factory

An all-electric, variable speed Chart Mover invaluable for testing . . . research . . . development work. A single drum kymograph, it can be used for keying production; for laboratory performance tests; for timing tests of equipment under operation.

A geometrical speed ratio – each speed 1.6 times faster than preceding speed – makes the G&G MONODRUM outstanding in its adaptability.

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MONODRUM provides moving charts for recordings. Selection of paper depends on phenomenon to be recorded, type of record desired, and cost limitations. Tell us your requirements. Following papers available:

LIGHT SENSITIVE
PHOTO SENSITIVE
PHOTO PRINTING
SOOTED
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Write for Complete Details!

For All Graphic Recording

Use it for driving timers . . . impulse and sequence controls . . . *any* purpose where absolute accuracy of motion is needed. Simplicity of construction – only 3 moving parts. Speed-changing knob permits easy variation, with indicator instantly showing change. *Twenty useful speeds!*

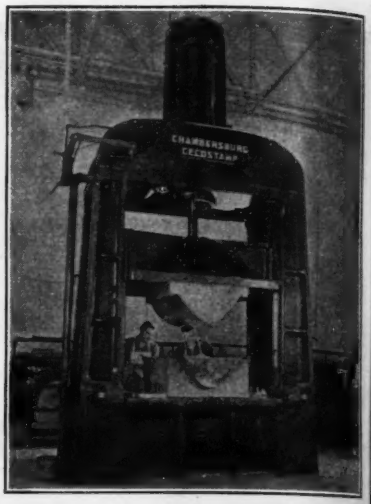
AC shaded pole, sparkless motor in two types – *HiSpeed,* for usual work requiring power and constant speed, or *Synchronous,* providing slower speeds with dead-beat, electric-clock accuracy. Standard all-aluminum drums 20" tall, 6¼" dia. Steel housing; baked enamel, inside and out.

Write for illustrated booklet "A Second or A Decade".

Makers & Originators of Recording Equipment since 1925

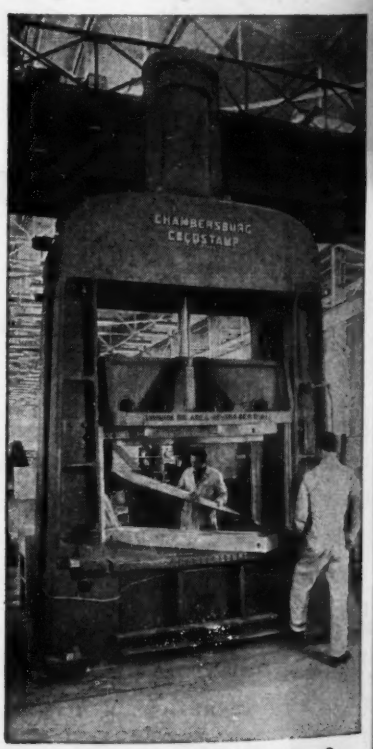
Correll & Correll

NEWTON CENTRE 59B, MASS.



The Cecostamp Solves New Metal Forming Problems

THE Cecostamp was designed by Chambersburg to meet and solve these problems: Forming tougher, more elastic alloy sheets in clear-cut die impressions without tearing, wrinkling or reduction of section, to accurate limits without mismatching and speeding the production of such parts. How well it has done so is indicated by the fact that practically every aircraft manufacturer in the United States, and many of the most important ones in the countries of our Allies, are using Cecostamps.



Chambersburg Engineering Co.
Chambersburg, Penna.

CHAMBERSBURG

Looking toward the post-war years . . . when expanding civilian air traffic will make adequate crash fire protection a "must" . . . Detroit City Airport has met the challenge with this big-capacity, fast-acting Cardox Airport Fire Truck.

This truck . . . the first of its kind to be made available to a civilian airport . . . is a highly specialized fire-fighting unit, based upon experience gained in producing hundreds of Cardox Airport Fire Trucks for military bases in the United States and abroad.

Self-contained . . . highly mobile . . . geared for easy maneuverability . . . it packs the terrific wallop needed to knock out crash fires fast and make possible speedy rescue of plane personnel. *Two* tons of liquid CO_2 can be released onto the fire zone in approximately one minute, if necessary. Backing up this big supply of zero-cold, fast-acting carbon dioxide is 220 gallons of foam solution . . . which blankets exposed gasoline and hot metal surfaces during and after extinguishment to prevent possible reignition.

Overwhelms Vicious Crash Fires With Amazing Speed

Cardox Airport Fire Trucks are the only mobile units which combine the two fast, efficient extinguishing mediums in these large quantities to conquer the vicious fires that can result when a big plane crashes. Crash fires involving heavy bombers, frequently carrying thousands of gallons of aviation gasoline, have been literally overwhelmed by this "mass attack" . . . permitting rescue of personnel in *seconds* after the Cardox Truck reached the scene of the crash.

Pictures shown above were taken during demonstration held at the Detroit City Airport. Small picture at left shows fire at its height. Center picture shows the beginning of the attack by the Cardox Truck, discharging CO_2 at the rate of approximately 4000 pounds a minute. Picture at right—*made 30 seconds after extinguishment was begun*—shows all fire extinguished.

New Bulletin Gives Full Facts

Airport authorities facing the problem of adequate fire protection for present and post-war operations should get full details on design, operation and performance records of Cardox Airport Fire Trucks. Write today for Bulletin No. 355.

CARDOX CORPORATION
BELL BUILDING • CHICAGO 1, ILLINOIS
District Offices in New York • Washington
Detroit • Cleveland • Atlanta • Pittsburgh
San Francisco • Los Angeles • Seattle

CARDOX
CO_2 FIRE EXTINGUISHING SYSTEMS

IT'S UP TO YOU TO HELP MAKE 2=3 WITH...

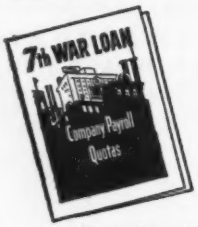
A job for seasoned executives—this 7th War Loan! Especially when we've got to make 2 war loans total just about as much as all 3 in 1944! Putting this over demands the combined and *continued* efforts of the "No. 1" men of American industry.

This means marshaling your plant drive to make every payday—from now 'til June 30th—do its share toward the success of the 7th. Directing the drive is not enough. It's equally important to check to see that your directions are being carried out—intelligently!

For example, has every employee had:

1. an opportunity to see the new Treasury film, "Mr. and Mrs. America"?
2. a copy of "How To Get There," the new Finance Division booklet?
3. a new bond-holding envelope with explanation of its convenience?
4. 7th War Loan posters prominently displayed in his or her department?
5. information on the department quota—and an urgent personal solicitation to do his or her share?

Remember, meeting—and beating—your highest-yet 7th War Loan quota is a task calling for "No. 1" executive ability. Your full cooperation is needed to make a fine showing in the 7th! Do not hesitate to ask your local War Finance Chairman for any desired aid. It will be gladly and promptly given.



If you haven't a copy of this important booklet, "7th War Loan Company Quotas," get in touch immediately with your local War Finance Chairman.

The Treasury Department acknowledges with appreciation the publication of this message by

AVIATION

★ *This is an official U. S. Treasury advertisement prepared under the auspices of Treasury Department and War Advertising Council* ★

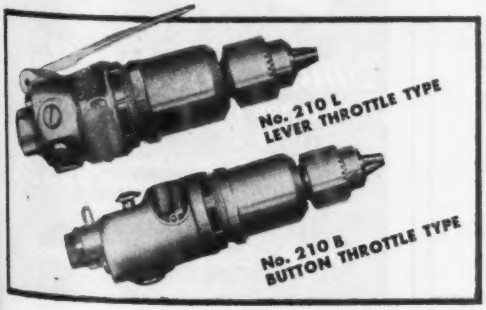
2" SHORTER FOR USE WHERE EVERY INCH *Counts!*

No. 210 G
PISTOL GRIP TYPE

NEW *Thor* PNEUMATIC DRILL MAKES DIFFICULT AIRCRAFT JOBS *EASIER!*

CHECK THESE ADVANTAGES:

- *Reduced overall length.* The No. 210G is now 5¾", as compared to 7¾" before . . . More compact and sturdier . . . The perfect tool for a full range of drilling uses.
- *Handle locks rigidly* to gear case and provides positive protection against accidental loosening of threaded housing parts.
- *Redesigned, hand-fitting* pistol-grip throttle handle, with pinch-proof trigger, placed on side of cylinder to improve balance and ease of handling.
- *Powerful new-type rotor* of THOR one-piece construction rotates on precision ball bearings. Long, smooth-running, trouble-free operation is assured.
- Automatic Lubrication of motor protects it from wear and corrosion due to moisture in compressed air.



Here's more drill in less space with less weight. Better balanced for greater efficiency. This new THOR air drill is compact, sturdy . . . a "honey to handle." Finds many uses in aircraft assembly—particularly drilling in channel sections, skins, contours, spars, wings and fuselage where limited space bars larger drills. Production line men are quick to spot the improved design, balance and easier handling that mean less fatigue . . . more and better work.

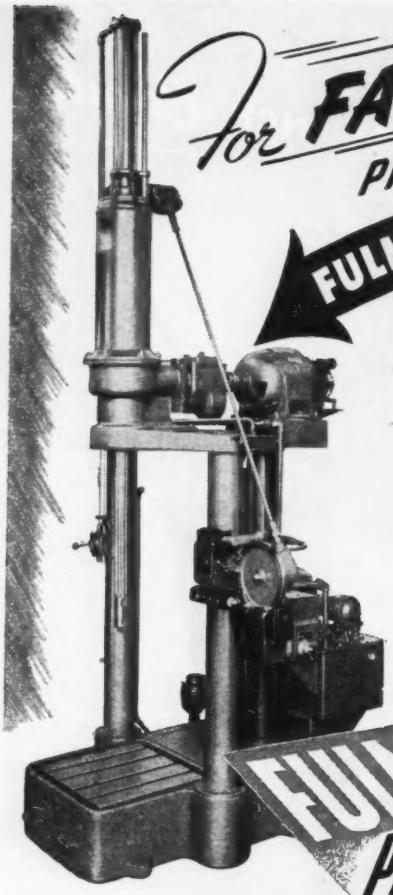
THOR tools that today help to keep production lines rolling will later serve the peacetime needs of the nation. For every material or operating condition, there is a THOR portable tool—pneumatic or electric—that is available in a full range of sizes, speeds, torques and capacities.

Thor PORTABLE *Electric & Pneumatic* TOOLS

Branches in Principal Cities

Write today for your copies of THOR pneumatic and electric Tool Catalogs.

INDEPENDENT PNEUMATIC TOOL CO.
600 W. Jackson Blvd., Chicago 6, Illinois
New York Los Angeles



For **FASTER** PRECISION HONING....

FULMER HONING MACHINE

THE Fulmer Honing Machine produces round, straight, smooth bores to working tolerances as small as .0002". It is an extremely flexible machine. Due to a wide range of spindle and reciprocating speeds, it removes material **faster than any other known method for a comparable degree of accuracy and surface finish.**

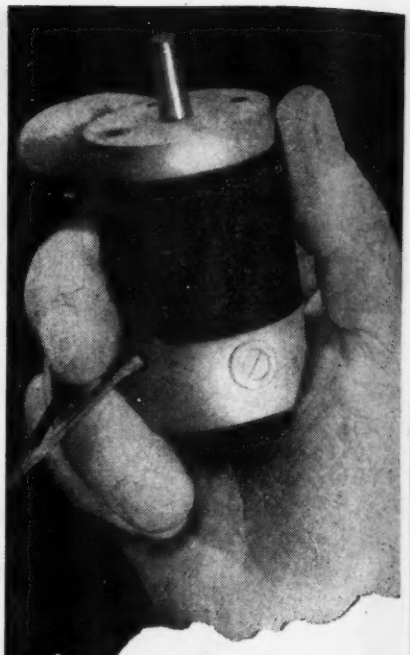
It is ideal for finishing aircraft cylinders, connecting rods, Diesel, gas and compressor cylinders, supercharger parts, landing gear struts, recoil cylinders—wherever superfine cylinder surfaces and extreme accuracy are required. Write today for complete information.

C. ALLEN FULMER CO.
1225 First National Bank Bldg., Cincinnati, Ohio

FULMER PRECISION SERVICE EQUIPMENT

PISTON RING LAPPERS
SPECIAL MACHINERY
HONING MACHINES
ROD BORERS

DEALERS: *A few attractive territories remain open. Write today!*



IT PACKS A BIG PUNCH

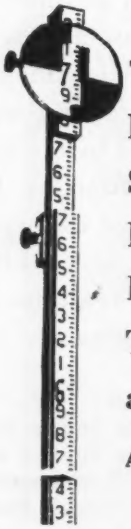
It's small but lusty —concentrated power for dependable performance on many types of jobs requiring maximum power per ounce of weight. 1/20th to 1/200th H. P. From 3000 to 20,000 R. P. M. 6 to 115 volts AC-DC. It's engineered and precision-built to your exact specifications. What type of small fractional H. P. motor do you need? Send specifications and quantity wanted. Write today.

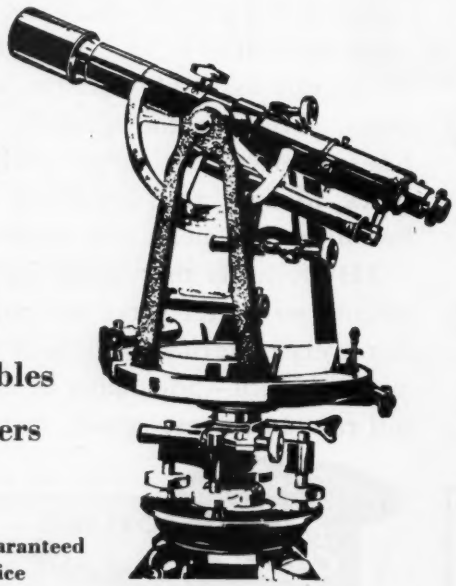
Small Motors, Inc.
1312 ELSTON AVE., CHICAGO 22, ILLINOIS

Manufacturers of special small universal, fractional H. P. motors, dynamotors, shaded pole motors, heater motors, generators.

Design · Engineering · Production

Engineers
FIELD and DRAFTING EQUIPMENT
Instruments and Materials of Highest Quality





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Prompt Service

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DRAWING MATERIALS — SURVEYING INSTRUMENTS
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Established 1860

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SHELDON M. BOOTH, President

Executive Offices and Factory ★ 938 East 41st Street ★ Chicago, Illinois

15 Factory Branches ★ Mill Supply Jobbers Everywhere

Sole Producers of — DTCo ★ LOC-KEY-SET ★ RE-SET-ABLE ★ BIG-HED-NIB — DIAMOND TOOLS

TRADE MARKS REGISTERED U. S. PAT. OFFICE

MOUNTED DIAMOND DRESSERS IN STOCK — READY FOR SHIPMENT

MADE IN U.S.A. — WORLDWIDE SERVICE

"C" Tools contain Common Quality Diamonds. Price $12.00 per carat. (Weight stamped on tools)
"M" Tools contain Medium Quality Diamonds. Price $24.00 per carat. (Weight stamped on tools)
"S" Tools contain Select Quality Diamonds. Price $48.00 per carat. (Weight stamped on tools)

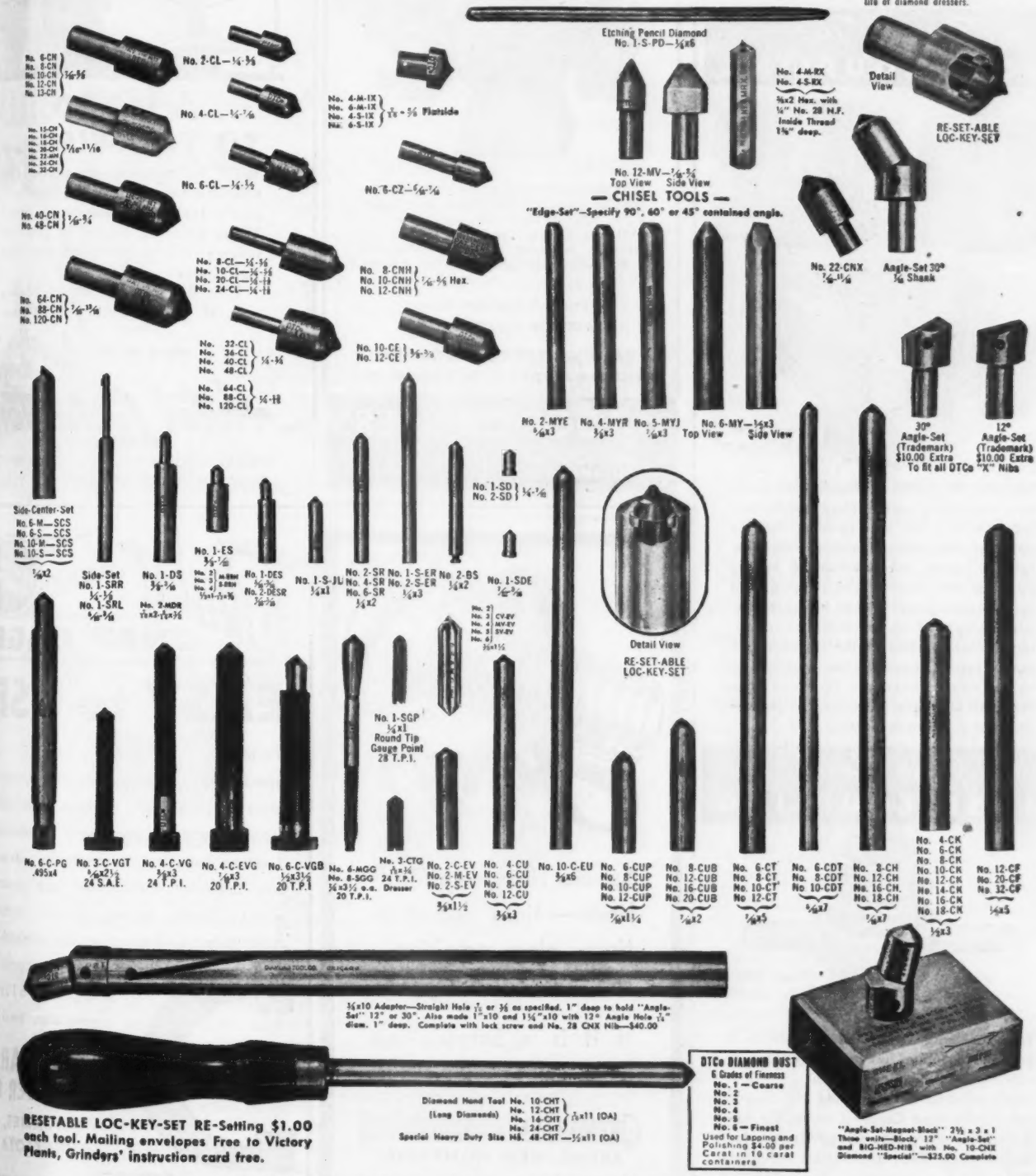
"C" Tools listed below can be obtained in Medium or Select grades by substituting "M" or "S" instead of "C" in the tool number.

Any Nib Tool is obtainable with short shank (7/16" long) by adding "X" to letter designation

Minimum price of $5.00 is charged for small fractional carat tools. All prices are net.

All DTCo Tools are LOC-KEY-SET

RE-SET-ABLE means more for your money. Prolongs the life of diamond dressers.


No. 6-CN, No. 8-CN, No. 10-CN, No. 12-CN, No. 13-CN
No. 2-CL—1/4-3/16
No. 4-CL—1/4-1/16
No. 15-CN, No. 16-CN, No. 18-CN, No. 20-CN, No. 22-MM, No. 24-CN, No. 32-CN
No. 6-CL—1/4-1/32
No. 40-CN, No. 48-CN
No. 8-CL—1/4-3/16
No. 10-CL—1/4-1/8
No. 20-CL—1/4-1/8
No. 24-CL—1/4-1/8
No. 64-CN, No. 88-CN, No. 120-CN
No. 32-CL, No. 36-CL, No. 40-CL, No. 48-CL
No. 64-CL, No. 88-CL, No. 120-CL
No. 4-M-IX, No. 6-M-IX, No. 4-S-IX, No. 6-S-IX
No. 6-CZ—5/64-1/16
No. 8-CNH, No. 10-CNH, No. 12-CNH Hex.
No. 10-CE, No. 12-CE
Etching Pencil Diamond No. 1-S-PD—1/16x6
No. 12-MV—1/16-3/16 Top View Side View
No. 4-M-RX, No. 4-S-RX
1/4x2 Hex. with 1/4" No. 28 N.F. Inside Thread 1 1/16" deep.
Detail View
RE-SET-ABLE LOC-KEY-SET
No. 22-CNX 1/16-1/16
Angle-Set 30° 1/16 Shank
— CHISEL TOOLS —
"Edge-Set"—Specify 90°, 60° or 45° contained angle.
No. 2-MYE 1/16x3
No. 4-MYR 3/32x3
No. 5-MYJ 1/16x3
No. 6-MY—1/16x3 Top View Side View
30° Angle-Set (Trademark) $10.00 Extra To fit all DTCo "X" Nibs
12° Angle-Set (Trademark) $10.00 Extra "X" Nibs
Side-Center-Set No. 6-M—SCS No. 6-S—SCS No. 10-M—SCS No. 10-S—SCS 1/16x2
Side-Set No. 1-SRR 1/16-1/16 No. 1-SRL 1/16-3/16
No. 1-DS 3/16-1/16
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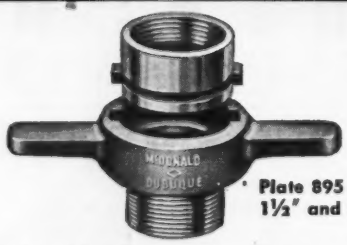

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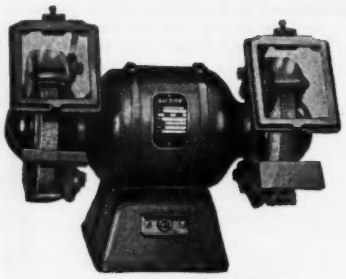

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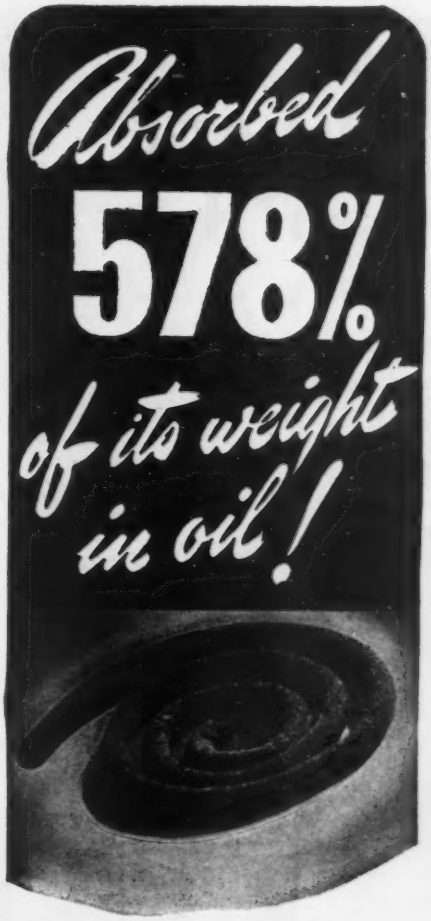

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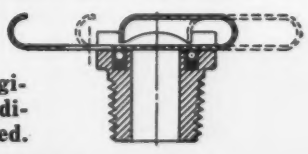

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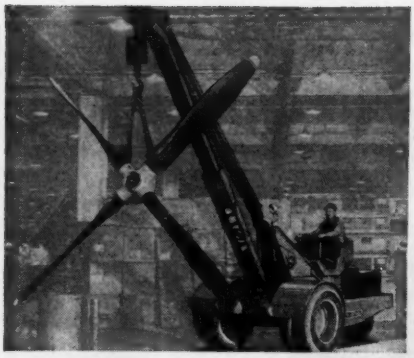

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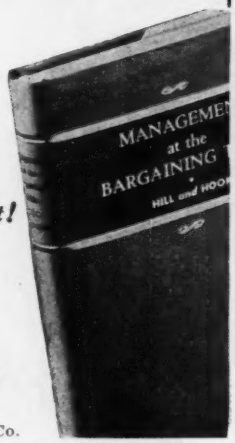

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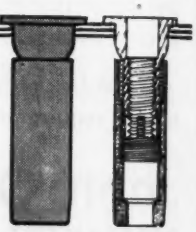
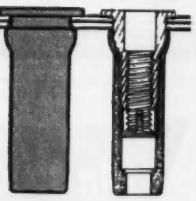
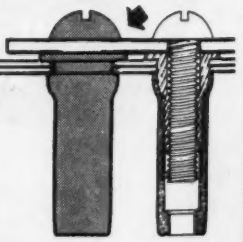


3 Riveted securely by drawing sleeve against inner side of metal with special power or hand tool.



4 Attachment fastened by screw locked in anchor nut.



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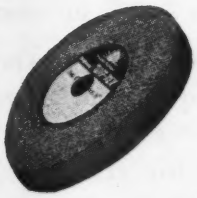

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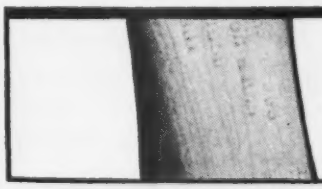

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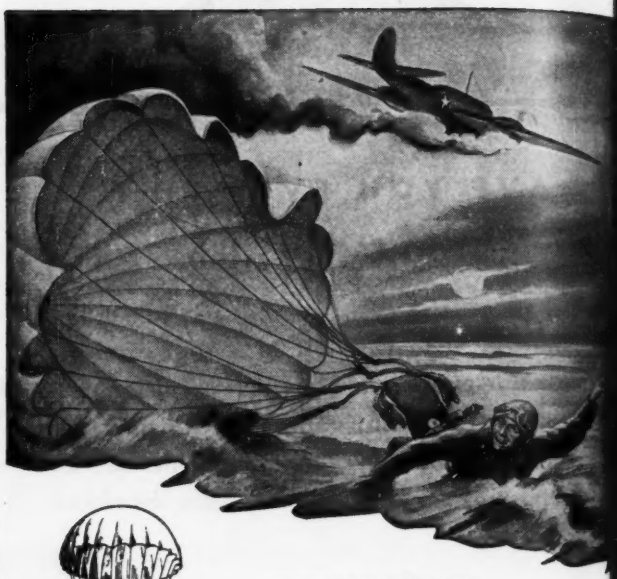

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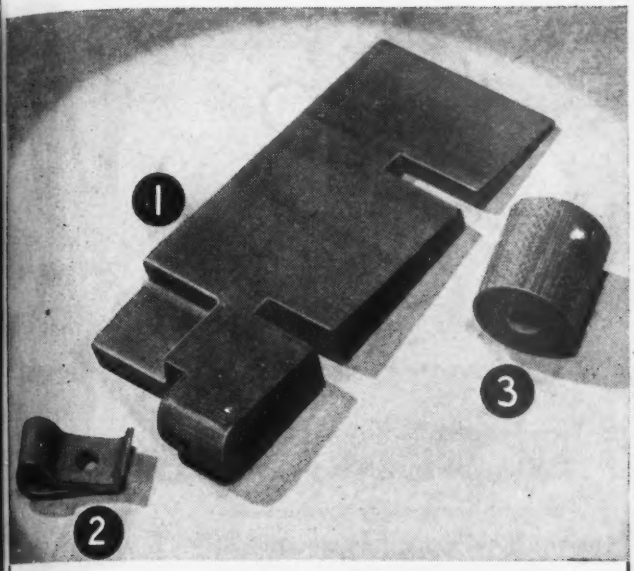

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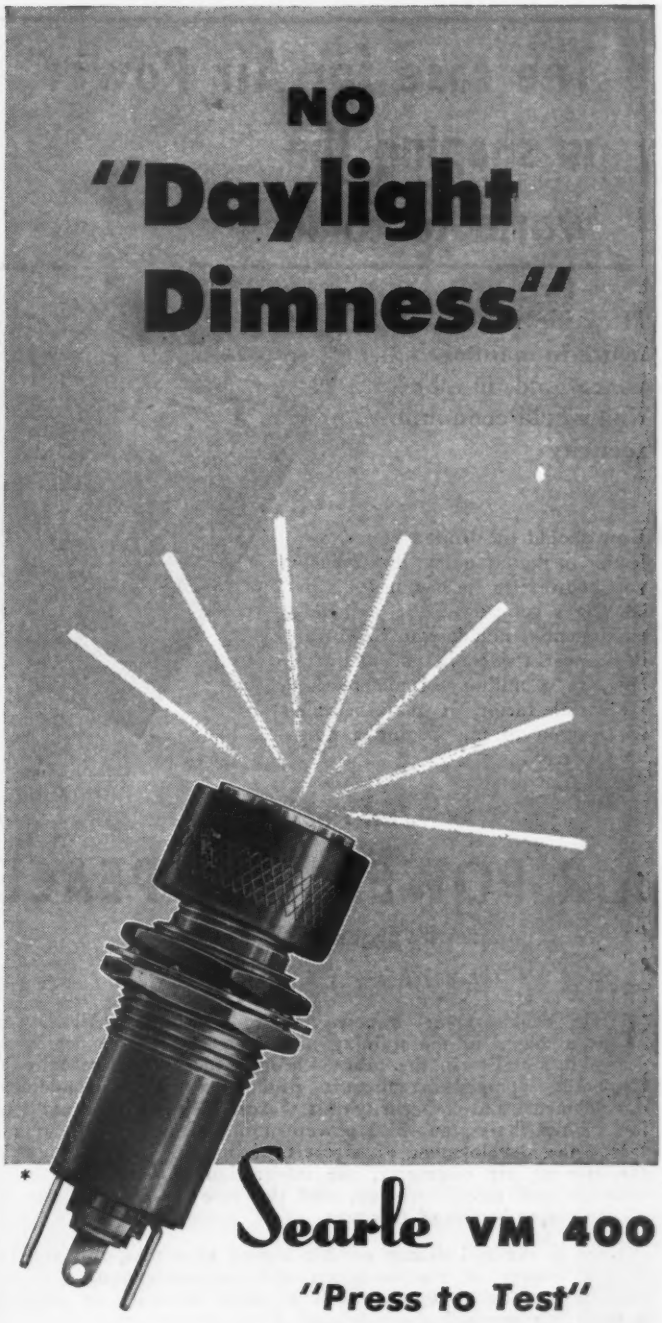

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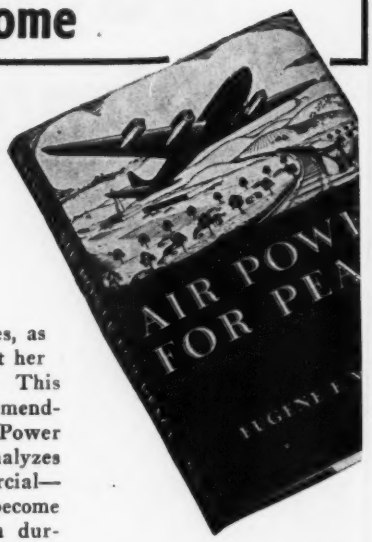

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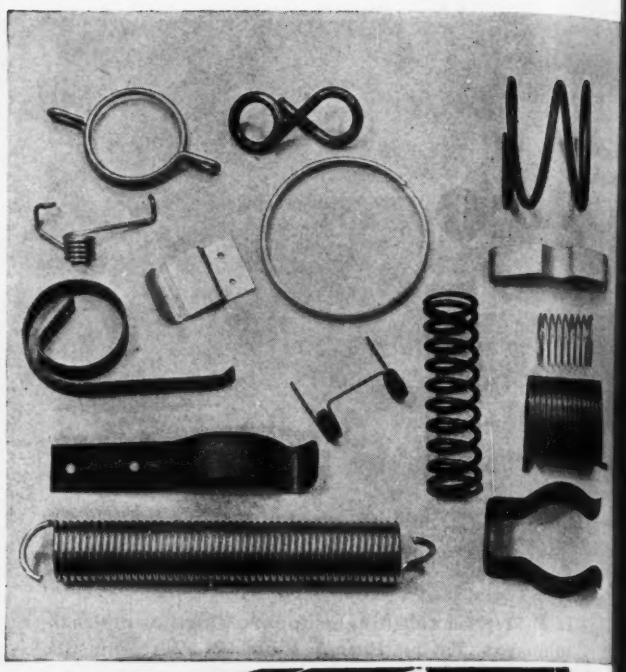

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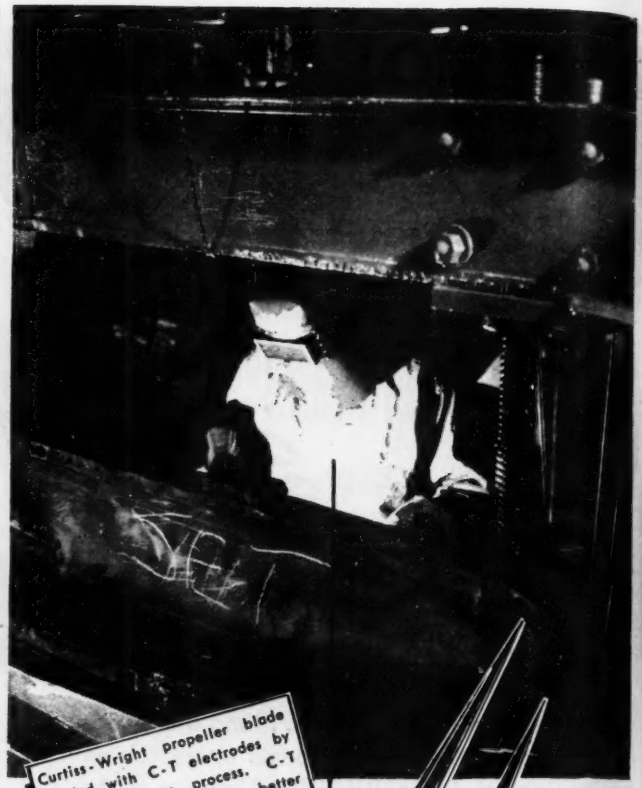

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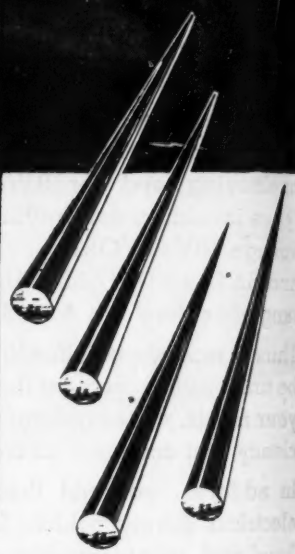

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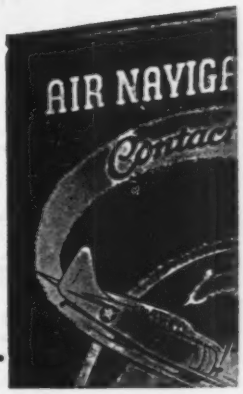

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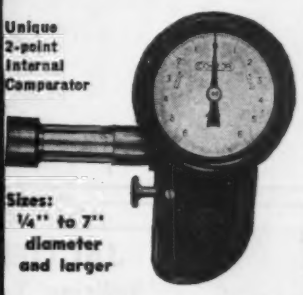

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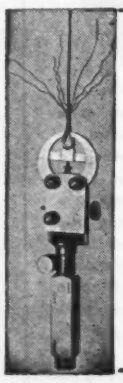

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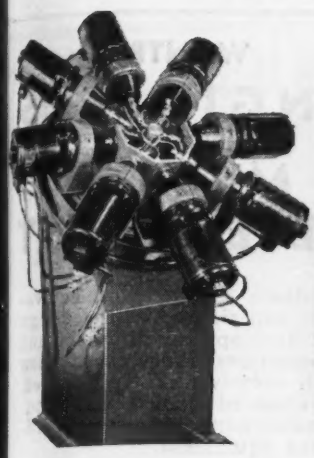

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3/32"	9/16"	8
1/8"	3/16"	10
1/8"	1/4"	20
1/8"	5/16"	20
1/8"	3/8"	25
1/8"	7/16"	20
1/8"	1/2"	29
1/8"	9/16"	19
1/8"	5/8"	30
1/8"	11/16"	30
1/8"	3/4"	16
1/8"	13/16"	22
1/8"	15/16"	14
1/8"	1"	9
1/8"	1 1/4"	15
1/8"	1 5/16"	15
1/8"	1 3/8"	10
1/8"	1 7/16"	10
1/8"	1 1/2"	10
1/8"	1 5/8"	5
1/8"	1 3/4"	5
1/8"	2"	5
3/16"	3/8"	3
3/16"	7/16"	5
3/16"	1/2"	8
3/16	9/16"	10
3/16"	5/8"	8
3/16"	11/16"	19
3/16"	3/4"	20
3/16"	13/16"	25
3/16"	7/8"	20
3/16"	15/16"	25
3/16"	1"	16
3/16"	1 1/16"	21
3/16"	1 1/8"	21
3/16"	1 3/16"	21
3/16"	1 1/4"	21
3/16"	1 5/16"	26
3/16"	1 3/8"	26
3/16"	1 7/16"	46
3/16"	1 1/2"	46
3/16"	3 1/16"	6
3/16"	3 1/8"	20

NAF 671 Rivets, Alum. Alloy, Brazier Head, Modified

DIA.	LENGTH	LBS.
3/32"	1/2"	22
1/8"	1/4"	5
1/8"	3/8"	21
1/8"	1/2"	18
5/32"	1/4"	10
5/32"	3/8"	15
5/32"	3/4"	5
3/16"	1/4"	10
3/16"	3/8"	18
3/16"	1/2"	42
3/16"	3/4"	10

AN 1008 Rivets, Universal Head, Alum. Alloy

DIA.	LENGTH	LBS.
1/16"	3/16"	192
1/16"	1/4"	150
1/16"	5/16"	149
1/16"	3/8"	433
3/32"	3/16"	100
3/32"	1/4"	400
3/32"	5/16"	43
3/32"	3/8"	350
3/32"	7/16"	50
1/8"	3/16"	65
5/32"	5/8"	42
3/16"	3/8"	100
3/16"	1/2"	80

NAF 1031 Rivets, Alum. Alloy, Flat Head 120 degree Countersunk

DIA.	LENGTH	LBS.
3/32"	3/16"	50
3/32"	1/4"	50
3/32"	5/16"	57
3/32"	3/8"	50
3/32"	7/16"	14
3/32"	1/2"	41
1/8"	1/4"	41
1/8"	5/16"	58
1/8"	3/8"	25
1/8"	7/16"	22
1/8"	1/2"	20
5/32"	1/4"	42
5/32"	5/16"	25
5/32"	3/8"	32
5/32"	3/4"	34
3/16"	1/2"	87
3/16"	3/4"	26
1/4"	3/4"	30

NAF 1163 Rivets, Alum. Alloy, Brazier Head, Special.

DIA.	LENGTH	LBS.
1/16"	3/16"	9
1/16"	1/4"	9
1/16"	5/16"	7
1/16"	3/8"	9
1/16"	7/16"	7
1/16"	1"	10
3/32"	3/16"	9
3/32"	5/16"	21
3/32"	3/8"	2
3/32"	7/16"	21
3/32"	5/8"	20
3/32"	3/4"	20
3/32"	1"	2
1/8"	3/16"	13
1/8"	1/4"	10
1/8"	5/16"	25
1/8"	3/8"	26
1/8"	7/16"	23
1/8"	5/8"	17
1/8"	7/8"	18
1/8"	1"	16
1/8"	1 1/4"	41
1/8"	1 1/2"	29
5/32"	1/4"	37
5/32"	5/16"	39
5/32"	3/8"	37
5/32"	7/16"	35
5/32"	1/2"	9
5/32"	5/8"	28
5/32"	3/4"	25
5/32"	7/8"	20
5/32"	1"	28
5/32"	1 1/4"	41
5/32"	1 1/2"	20
5/32"	1 3/4"	20
5/32"	2"	36
3/16"	1/4"	41
3/16"	5/16"	38
3/16"	3/8"	38
3/16"	3/16"	81
3/16"	1/2"	74
3/16"	9/16"	57
3/16"	5/8"	79
3/16"	7/8"	38
3/16"	1"	68
3/16"	1 1/4"	84
3/16"	1 1/2"	76
3/16"	1 3/4"	38
3/16"	2"	39
3/16"	3"	22
1/4"	1"	10
1/4"	1 1/2"	21
1/4"	2"	7
1/4"	5"	17

NAF 210988 Rivets, Alum. Alloy, Oval Head, Countersunk, Annealed, Heat-treated 17st.

DIA.	LENGTH	LBS.
1/16"	3/16"	294
1/16"	1/4"	163
1/16"	5/16"	235
1/8"	1/4"	257
1/8"	5/16"	67
1/8"	3/8"	228
1/8"	1/2"	256
1/8"	1"	360
5/32"	5/16"	124
5/32"	3/8"	29
5/32"	7/16"	18
5/32"	1/2"	236
5/32"	1"	301
3/16"	5/16"	74
3/16"	3/8"	153
3/16"	7/16"	70
3/16"	1/2"	105
3/16"	1"	246
1/4"	3/8"	97
1/4"	7/16"	102
1/4"	1/2"	170
1/4"	3/4"	205
1/4"	1"	270
5/16"	1/2"	213
5/16"	7/16"	106
5/16"	3/4"	183
5/16"	1"	315
5/16"	1 1/4"	83
3/8"	1/2"	207
3/8"	1"	204
3/8"	1 1/2"	156
7/8"	3/4"	178
7/8"	1 1/4"	203
7/8"	1 3/4"	101
1/2"	3/4"	159
1/2"	1 1/4"	106
1/2"	2"	202

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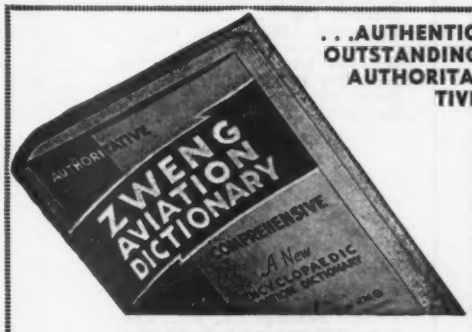

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OR LOCAL PROJECTS

Separate and tie in bundles: 1. Wastebasket scraps. 2. Corrugated boxes, brown paper and bags. 3. Magazines and books. 4. Newspapers.

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